NATURE

No. 4414 SATURDAY, JUNE 5, 1954 Vol. 173

CONTENTS

	Page
Selection of University Students	1055
An Anthology of Whitehead. By Sir Edmund Whittaker, F.R.S.	1058
Technical Aspects of Audible Sound. By Dr. H. D. Parbrook	1058
A New Approach to the Mechanics of Solids. By Prof. R. Hill	1059
Proteins and their Nature. By Dr. D. P. Riley	1059
The 1954 Meeting of the British Association in Oxford. By Dr. D. B. Harden	1062
Toxic Chemicals in Agriculture and their Effect on Foodstuffs. By Dr. Francis Aylward	1063
Speciation of Fishes in African Lakes. By Dr. E. B. Worthington	1064
New Radiochemical Facilities at Harwell and Amersham	1067
National Physical Laboratory, Teddington : Open Day	1069
Obituaries :	
Sir John Blake. By J. N. Brown, C.B.E.	1071
Prof. Paul Selényi. By Dr. Francis Körösy	1071
News and Views	1072
The Borough Polytechnic, London : New Extension Building. By Dr. Francis Aylward	1076
Luminescence of Inorganic Phosphors. By Dr. G. F. J. Garlick	1077
Atmospheric Contamination in Industry and the Health of the Worker. By R. J. Sherwood	1078
Distribution Maps of the British Flora. By Dr. S. M. Walters	1079
Rockefeller Foundation Grants	1080
Use of Synthetic Detergents in Great Britain	1081
Play in Domestic Cattle in Britain : an Analysis of its Nature	1081
Protein Metabolism in Leaves	1082
Growth-promoting Substances in the Ovary and Immature Fruit of the Banana. By Prof. F. C. Steward and Dr. N. W. Simmonds	1083
Controlled Sporulation of *Cercospora musae* Zimm. in Pure Culture. By Lucas Calpouzos	1084
Letters to the Editors :	
Probable Side-effect of Nuclear Reactions in the Biological Action of Fast Protons.—Dr. Lars Ehrenberg and Dr. Göran Andersson	1086
Some Effects of Neutron Irradiation of Diamond.—A. H. Benny and Dr. F. C. Champion	1087
Electron Resonance in Ionospheric Waves.—C. O. Hines	1087
A New Gloss Meter incorporating a Method for Accurately Measuring the Polarization of Light.—L. F. Hopkins and A. P. Highton	1088
The Einstein Relation between Relative Viscosity and Volume Concentration of Suspensions of Spheres.—A. J. Hughes ; Donald R. Oliver and Prof. Stacey G. Ward	1089
A Study of Manganous Complexes by Paramagnetic Resonance Absorption.—Mildred Cohn and Jonathan Townsend	1090
Anionotropy catalysed by Lewis Acids.—Dr. E. A. Braude and P. H. Gore	1091
Threonine and the Odour of Protein Hydrolysates.—Dr. D. M. P. Phillips	1092
Volatile Acids of Ox Perinephric Fat.—R. P. Hansen and A. G. McInnes	1093
Biochemical and Osmotic Properties of Skeletal Muscle Mitochondria.—J. B. Chappell and Dr. S. V. Perry	1094
Cytological Fixation of Mitochondria by Acids.—Dr. W. G. Bruce Casselman and Miss Barbara M. Jordan	1095
Influence of Mammalian Growth Hormone on Rate of Growth of Fish.—D. R. Swift	1096
Effect of Mercury Vapour on the Active Uptake of Sucrose by Leaf Tissues.—G. A. Pennell and Dr. P. E. Weatherley	1096
Boron Deficiency in Oil Palms in the Kasai Region of the Belgian Congo.—J. D. Ferwerda	1097
A Virus Latent in Carnation and Potato Plants.—Dr. B. Kassanis	1097
Steroidal Sapogenins in Amazonian Plants.—Dr. R. F. A. Altman	1098
Observations on the Iodo-Amino-Acids of Marine Algae using Iodine-131.—Richard Scott	1098
Occurrence of *Durvillea caepestipes* on Chatham Island.—Margaret Naylor	1099
A Liquid Medium for the Cultivation of *Trypanosoma cruzi*.—Nathan Citri and Dr. Nathan Grossowicz	1100
A Toxic Nitro Compound from *Streptomyces thioluteus*.—Yoshimasa Hirata, Kunio Okuhara and Takayuki Naito	1101
Occurrence of Susceptibility to Carbon Dioxide in *Drosophila melanogaster* from Different Countries.—Dr. H. Kalmus, Jill Kerridge and Dr. F. Tattersfield, O.B.E.	1101
"Social Conditions and the Development of Science".—Prof. L. Rosenfeld ; Prof. Herbert Dingle	1102

SELECTION OF UNIVERSITY STUDENTS

IT is no bad thing that a broadsheet entitled "Graduate Wives" (No. 361 ; April 5, 1954), recently issued by Political and Economic Planning, has provoked considerable discussion regarding the value of university education for women, and perhaps more particularly when that education has only been possible because of the help received from public funds in some form or another. That latter point was not specifically covered by the inquiry, although it is noted that many thousands of pounds of public money are spent on the education of the four thousand women graduates who leave the universities of Great Britain every year. The inquiry covered by this broadsheet related to only a small sample, but there is no reason for believing that it was not representative or that it contained less than the usual proportion of students who hold university scholarships or some other award from public funds.

The majority of the graduate wives covered by this inquiry were probably making no direct use of their academic qualifications ; for most of them the career planned, implicit in their university course, ended in marriage. For some ten per cent, that career was only halted temporarily while children were very young, and a further ten per cent took up free-lance or part-time work as the children grew up. Only three per cent gave shortage of domestic help as a reason for giving up a career. Many women graduates wished to take up full-time or part-time work outside their homes when they had an opportunity to do so, and of this group twenty-six per cent wished to teach and four per cent to return to medicine. As for graduate wives still engaged in their profession, teaching is the dominant occupation : nine per cent of those engaged full-time and nineteen per cent of those working part-time were teaching.

While almost a negligible proportion of the graduate wives were helping their husbands professionally, the fact that the majority of those covered by this inquiry made no direct use of their academic qualifications after marriage does not imply that the public money expended on their university education has been wasted, though it may well induce some re-examination of the system of university awards and a fuller consideration of the whole purpose of university education. As the broadsheet points out, the indirect contribution which a trained mind and cultured outlook can make to family life and to the life of the nation generally is very great indeed. Important as is the work of the universities in training men and women for the professions, that is only a part of their task—a point which the Archbishop of York emphasized in his sermon before the University of Leeds at its jubilee celebrations on April 25.

Besides its duty to seek and to teach the truth, a university must train its students to handle truth aright. This requires courage as well as knowledge. We need many more men and women in all walks of life with the wisdom and independence to make up

their own minds and to act on what they believe to be right. The national life would be the poorer if we debarred from a university education all those women who were not willing to renounce any claims that would prevent them from continuing to practise throughout life a vocation for which they once qualified academically. The very extent to which we succeed in correcting the excessive specialization against which Dr. Garbett warned his congregation, and in imparting the vision, wide sympathies and understanding to which he referred, increases the importance of allowing, to some extent at least, this leaven to work directly in the home.

Dr. Garbett was here emphasizing a point which was also argued recently by Sir Charles Morris in his Joseph Payne Memorial Lectures to the University of London. Like Dr. Garbett, Sir Charles quoted Newman's definition of a university as in its essence, "a place for the communication and circulation of thought, by means of personal intercourse, through a wide extent of country"; and in seeking a means of correcting the dangers of specialization, especially on the scientific side, he urged that even from a utilitarian point of view the scientist or technologist needs more than general grounding in one or more of the natural sciences. Just as much as the judge, the administrator or the statesman, he needs training which equips him to judge human situations with integrity, to reason cogently and with power, and which has steeped him in reflexions on the general condition of mankind.

To the extent to which the minds of young men and women are once opened to the influence of education at this level, the value of a university education can never be entirely lost; nor is the money expended on it wasted even if the student fails to obtain a degree or to practise a profession or vocation for which the degree would fit him. He has gained something which can never be taken away and which must influence for the better his whole attitude to life. The alarm with which Mr. J. F. Wolfenden, vice-chancellor of the University of Reading, regards the increasing numbers of students who enter the universities purely with the object of obtaining a degree arises from the belief that, in gaining a third-class degree, such students may indeed get some sort of passport to a job but miss the essence of a university education.

Mr. Wolfenden believes that there are too many university students already who regard education simply and solely as a means of getting a job. Public money expended on the gaining of third-class degrees by such plodders is largely wasted, and Mr. Wolfenden, who was addressing the annual conference of the National Union of Teachers, repeated the suggestion which he had made in an article in *The Fortnightly Review* three years earlier on selecting some university entrants on other grounds than purely academic competition. The argument that, after making sure we have taken in the ten per cent or so of outstanding students who will take first-class or good second-class degrees, we should look for those who promise to be future leaders in the community—in press and radio, in industry and agriculture, as well as in the professional and academic world—is something more than an endorsement of Mr. Eric James's plea that we should take education for leadership seriously. It is based on Zinsser's belief that no democracy can maintain itself for any length of time without building up an aristocracy of ability and integrity to protect it from deterioration and eventual chaos. It is based, too, on the belief that those who carry away from the university—into the home or into any walk of life—the habitual vision of greatness are not merely the best qualified to give the nation the leadership it needs but also to mould and form a wise and sober public opinion on public affairs.

However sound the argument for Mr. Wolfenden's thesis, it will not be easy to find an acceptable basis for selection, even if the central government were to assume full financial responsibility for all scholarships and awards as *Planning* suggested last November, and if we discount the danger of a possible contingent loss of interest in university education by the local authorities. Meanwhile, just as our conception of the purpose of a university education requires sharpening, so does the question of selection require re-examination in that context. Simultaneously, the increasing dependence of a university education upon public funds is causing the use made of that education to be scrutinized more closely, as in the *Planning* inquiry, and the extent to which student failures can be prevented by more careful selection or in other ways has become the subject of inquiry by the School of Education at the University of Manchester and elsewhere.

Following Mr. Warburton's survey two years ago has come a study by Mr. R. R. Dale*. The work originated in 1949 in the concern which was felt among the staffs of universities as to the general standard of student attainment. An inquiry was made into the performance of a group of university scholarship holders in their first-year examinations, and this study became an examination of the transition from school to university, primarily of the problems presented in London and the provincial universities. It was concerned mainly with the selection of students, but had the wider purpose of indicating ways by which imperfections in educational guidance or in selection on the part of school, student or university which at present are responsible for wastage might be reduced so far as possible.

Some of those difficulties admittedly are temporary and due either to the changes in the entrance examination or to the great excess of applicants over places. Given the co-operation between school and university manifest at the Buxton Conference on grammar schools and universities organized by the Manchester Education Authority last January, much could be done to remove these difficulties and to supply the educational guidance both in the school and in the university on which Mr. Dale rightly lays

* From School to University: a Study, with special reference to University Entrance. By R. R. Dale. (International Library of Sociology and Social Reconstruction.) Pp. xi+258. (London: Routledge and Kegan Paul, Ltd., 1954.) 21*s.* net.

stress. In the school, he emphasizes the value of guidance competent to advise on choice of subject and vocational possibilities, and to direct pupils to those university departments where the bias is best suited to individual aptitudes, as well as to diagnose failures and initiate remedial measures. In the university, general guidance to entrants, he suggests, should place greater emphasis on instruction in the use of the library and in the most efficient methods of study. We can no longer assume that the average university entrant has an adequate awareness of the means of attaining knowledge.

This may well be a field in which the influence of a graduate mother is felt, whether or not she continues to follow the vocation for which she was trained; indeed, there is a point beyond which the most efficient system of university guidance can never compensate for the absence of a cultured home where learning is respected and habits of study and the use of books are understood as part of a civilized life. Further extension of the tutorial and seminar system could assist here, too; but when that has been pushed to the limits set by staff or buildings, the question of selection has still to be faced if we are to avoid wasting some at least of the improved facilities on those unable to profit by them. Some of the difficulties are of our own making. Mr. Dale's book shows clearly the desirability of a period of stability in regard to the entrance examination, of some agreed policy in regard to university awards and a clearer understanding of the purpose of a university education.

None the less, given all these matters and more liberal provision of hostel accommodation, the core of the problem will remain; nor does Mr. Dale suggest that the academic examination should cease to be the principal criterion for admission to a university. He recognizes its weaknesses and the need for supplementing it appropriately with the school report and record, the intelligence test or the interview, though the last he regards as the most dangerous of aids, chiefly to be used in reviewing all the evidence about an applicant. In fact, he appears to attach little importance to the diversity stressed by Mr. Wolfenden, and to seek a greater uniformity of standard among examining boards.

When all possible improvements have been effected in selection, failures will still be encountered. Mr. Dale agrees with Prof. I. L. Kandel as to the impossibility of predicting academic success with certainty; nor should more be expected than that university selection should eliminate so far as possible those intellectually incapable of benefiting by a university education and most of those whose lack of self-discipline renders them unworthy entrants. The chief cause of the failures examined in this study was not lack of ability but lack of application to work, arising essentially from the absence of sufficient self-control on the part of the student to put first things first and ration his social activities and his recreation as well as his extra-mural activities.

It is here that the influence of students of the type Mr. Wolfenden has in mind could be valuable, for Mr. Dale himself admits that, if selection is too tight, along with the work-shy many worthy students will be excluded. If some doubtful students are admitted, the example and leadership of those such as Mr. Wolfenden suggests admitting might well make all the difference between failure and success to such weaker brethren. The numbers admitted must, of course, bear a reasonable relation to the accommodation and staff available—at present the controlling factor—and the number of students admitted from the border group should depend on the ratio of staff to students being reasonably generous.

Good selection, as has been said, can only reduce, not eliminate, failures among this group of students, and when qualified students are waiting for places a university cannot allow them to be excluded by idlers. A stern policy is required towards failing students, though it is wrong to suppose that the public money spent on all such students is entirely wasted. Many, in fact, derive great benefit from their academic studies, and some contribute to the success of student activities.

Mr. Dale's study is far from exhaustive, and really demonstrates the wisdom of spending some money and effort in the attempt to discover how the use of public money on those unable to profit by a university education is best minimized. It cannot be entirely prevented, but the surest way to increase it is for the universities to fold their arms and say "J'y suis, j'y reste". As Prof. Arthur Smithells insisted many years ago, if educational institutions are to preserve their influence on the people, they must alter their ways, with the progress of civilization, in some measure as the people alter theirs; they must be ever alert not to become detached. The answers we give to questions such as whom to admit to universities, and the value of university education for women and the extent to which it should be fostered, turn not simply on the resources at our disposal, but also on our view of the purpose of a university and its function in the world of to-day. Whether like Mr. Dale we lean towards uniformity, or like Mr. Wolfenden towards diversity of function, that purpose must include the fourfold duty defined by Lord Curzon nearly half a century ago: "to provide the best teaching over the entire field of knowledge of which its own resources and the progress of science may admit; to offer this teaching to the widest range of students; to mould and shape them not merely by the training of intellect, but by the discipline of spirit, so that, wherever they go, they may be worthy citizens or worthy servants of the State; and to extend by original inquiry the frontiers of learning". There may be diverse opinions as to the order of importance of those duties; but all must be kept in mind when deciding on the means to be adopted for selecting students for admission, the standards of admission and the guidance given to those admitted. Indeed, on the extent to which those duties are effectively discharged under the conditions of to-day will largely depend the wisdom of our selection and the measure to which waste in university education is eliminated.

AN ANTHOLOGY OF WHITEHEAD

Alfred North Whitehead
An Anthology. Selected by Prof. F. S. C. Northrop and Dr. Mason W. Gross. Introductions and a note on Whitehead's Terminology by Mason W. Gross. Pp. 928. (Cambridge: At the University Press, 1953.) 75*s*. net.

WE are familiar with anthologies—collections of flowers, or beautiful passages—taken from the works of poets. To treat the writings of a philosopher in this way is less usual and has perhaps less evident justification. Of the 928 pages of the volume under review, more than half are taken from Whitehead's popular books, which are very readable and lend themselves to selection. But at the beginning we are faced with his Royal Society memoir, "On Mathematical Concepts of the Material World", one of the most difficult papers ever written. The apology offered for including it is the practical impossibility of obtaining a copy in any other way: the author distributed some offprints when the paper was published forty-eight years ago, but few can now possess one and it has never been reprinted. Later, there are nine chapters taken from "Process and Reality". The wisdom of including them in an anthology is doubtful, for they are by no means easy reading, and are of no interest to anyone but a serious student of Whitehead; a serious student would be sure to possess the whole book.

Whitehead's philosophy in its mature form was published in 1929, in his Gifford Lectures. Since then, it has been the subject of much study and discussion, and there has been time for the formation of some general trends of both approval and criticism. In his view, the beginnings of philosophy should be sought in arranging and contemplating the vast body of knowledge regarding the external world that has been gained by the labours of men of science. A scheme of broad conceptions must be constructed, fusing this knowledge into a rational cosmology; and further progress is then to be made by confronting the system with other types of experience and attempting to extend it so as to unify the whole.

These principles entail the consequence that philosophy, like science, must be a progressive subject. The conceptions of one generation must be replaced by those of the next: no interpretation of the external world, and therefore no explanation of the cosmos as a whole, can endure for ever. The tragedy of Whitehead's system is that it was completed just before the great modern revolution in physics, which was brought about by the discovery of quantum theory, attained such a stage of development that it could be incorporated rationally in a general scheme of Nature. Matrix-mechanics was discovered in 1925, and wave-mechanics in 1926, but they had not spread outside the narrow domain of the higher mathematical physics when the Gifford Lectures were delivered.

The new natural philosophy is based on the doctrine that the dynamical quantity which has been known for more than a century under the name of Action can exist only in multiples of a certain unit, which is called the Quantum of Action. It was found possible by use of this law to explain the puzzling fact that light behaved sometimes like a wave and sometimes as if it were composed of corpuscles; and it led to the prediction, which was verified experimentally, that electricity, which had previously been known only in the corpuscular form, must have some undulatory properties. These discoveries, however, were difficult to reconcile with the acceptance of the traditional space and time as the framework within which the philosophy of physics must be constructed; and a new foundation seemed to be called for.

In "Process and Reality", time and space are expressions of certain extensive and cogredient properties of events or *actual entities*, which Whitehead takes to be the final real things of which the world is made up. It is, however, extremely difficult to set up any correspondence in detail between the language used by Whitehead and that used in modern theoretical physics: he often refers to quantum theory, but, as we have seen, his philosophy took its final form before quantum theory developed into a rational science. The quantitative treatment of the external world has not yet been presented in a wholly satisfactory philosophic context.

EDMUND WHITTAKER

TECHNICAL ASPECTS OF AUDIBLE SOUND

Technical Aspects of Sound
Edited by Dr. E. G. Richardson. Vol. 1: Sonic Range and Airborne Sound. Pp. xviii+544. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1953.) 70*s*.

THE book under review is the first of two volumes on the "Technical Aspects of Sound". Vol. 1 deals with audible sound; Vol. 2 is to cover ultrasound and its applications. The stated aim of the two books is to provide a "handbook" covering "all the technical aspects of the subject . . . at a fairly advanced level" and to be of interest to the "research worker, industrialist and advanced student". Each aspect of the subject has been written by an authority in that field under the editorship of E. G. Richardson, who has also provided a short introduction to the "background of theoretical analysis".

In a handbook covering such a wide field, one looks for a terse, authoritative summary of the essential facts, together with detailed information in graphical or tabular form, and an extensive modern bibliography. Of the sections most in keeping with the scope of the book, mention should be made of the following contributions: L. L. Beranek on the measurement of frequency, pressure and velocity amplitudes, which is a terse, lucid statement; C. W. Kosten on the theory and measurement of acoustic absorption and on the theory of sound transmission (mostly airborne sound), which is easily the most advanced section in the book; the members of the Bell Telephone Laboratories on speech, hearing, speech-transmission rating and microphones, which is a good factual survey of the field presented mainly from the point of view of telephony; and J. and K. de Boer on stereophonic reproduction, which is an effective introduction that could have been extended.

Dr. Richardson's own contribution on musical instruments, the longest section in the book, seeks to assess some of the factors affecting tonal production. His two short chapters on electrophonic instruments and on sound analysis, particularly the section on transient sound analysis, contain few references to the not inconsiderable developments of recent years. The section on room acoustics by H. J. Purkis could

well have been written from a more advanced point of view. While the acoustic design of large auditoria is extremely interesting, the survey could also properly have included other design problems. The section on noise by A. J. King suffers from an almost exclusive preoccupation with the noise problems of a particular industry. That there is still no universally accepted objective noise meter, and that the sound-level meter cannot be considered as such a meter, might have been more adequately stressed. F. Spandöck's contribution on loudspeakers, telephones and sound recording, although containing much information, is partly marred by too great an interest in one manufacturer's products, by possible difficulties in translation from the German, by inadequate proof-reading and by a bibliography which is not entirely representative. In an appendix there is a table of "absorption coefficients of some European building materials". However, only proprietary so-called acoustic materials are mentioned.

The book contains a considerable amount of useful information, on aspects of technical acoustics, which, with the exception of Kosten's contributions, should be easily understood by the equivalent of a student in his final honours year. I think, however, that a better generic term for the book would be that of a series of reviews rather than that of a technical handbook.

H. D. PARBROOK

A NEW APPROACH TO THE MECHANICS OF SOLIDS

Analysis of Deformation

By Dr. Keith Swainger. Vol. 1: Mathematical Theory. Pp. xx+285. (London: Chapman and Hall, Ltd., 1954.) 63*s*. net.

DURING the past ten years, the macroscopic behaviour of solids under severe stresses has been studied intensively in Britain, the United States and the U.S.S.R. The most highly developed branch of this subject is the plastic deformation of metals. On the main theoretical and experimental foundations of this there is now universal agreement among authorities. In the past year or two, almost entirely through work done in Britain, predictions of the theory in regard to the behaviour of the common metals under quasi-static non-uniform loads at ordinary temperatures have received remarkable verification, often in the greatest detail. It is not too much to assert that the theory of finite plastic deformation is now as soundly based as the theory of infinitesimal elastic deformation. This achievement is so recent that it is not widely known, although fully described in the literature. (A short non-technical survey, with a fairly complete bibliography, has been given by B. B. Hundy in *Metallurgia*, March 1954, p. 109.)

Dr. K. Swainger refers to none of this recent work in this first volume and has virtually confined himself to an exposition of his own ideas. These differ radically from the accepted ones, though why the latter have been rejected is not clear from the very few comments made. Dr. Swainger's position can be illustrated by citing certain 'new facts' that he has obtained. According to the 'hoary theory on the infinitesimal deformation of elastic solids', the hydrostatic part of the stress (that is, the first invariant) normally varies from point to point in an elastic solid (pure bending is a simple example); it may, in fact, be any harmonic function. Dr. Swainger, however, states that this is too general and that it must be a constant (pp. 52, 59, 121, 162, 173, 174). In line with this he also concludes (p. 163) that the components of displacement are harmonic, instead of biharmonic. Again, on p. 50, he reaches the result that, when there are no body forces, the divergence of the resultant stress vector acting over octahedral planes is zero. It will be interesting to see, in the second volume on applications, how far Dr. Swainger can move, so heavily shackled (as one would think).

As a basis for a theory of plastic deformation of metals, Dr. Swainger postulates that the ratios of the components of an infinitesimal increment of plastic strain depend solely on the ratios of the components of the increments of stress, and not at all on the stress itself. This seems to be introduced into the analysis on p. 202 (or possibly on p. 103) but, so far as I can see, receives an unambiguous statement only on the last page of the book (p. 226). A typical implication of this postulate is the following: suppose a cylindrical tube is twisted plastically and that a small axial tension is then added while the torque is held constant at its final value. According to Dr. Swainger, the resulting plastic strain-increment would be a pure extension. Actually, it would be predominantly a twist. Here again one must await the second volume for enlightenment.

Not every would-be reader of this book will be prepared to sacrifice the time needed to master the singularly involved notation. (It is this which has probably been responsible for the very high cost of the book.) Nor will many have the requisite familiarity with dyadics, not to say the considerable degree of manipulative skill. It is a pity that Dr. Swainger has never found it possible to express himself in simpler terms. If he had, the differences of view would have been resolved long ago.

R. HILL

PROTEINS AND THEIR NATURE

The Proteins

Chemistry, Biological Activity, and Methods. Edited by Hans Neurath and Kenneth Bailey. Vol. 1, Part A. Pp. xi+548. 12 dollars. Vol. 1, Part B. Pp. ix+549–1116. 13 dollars. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.)

THERE is now no paucity of literature concerning the proteins. Much of this we owe to the publishers of the present work, who have indeed been of high service to the progress of the subject. It is difficult to exaggerate, for example, the value to the research worker of that admirable series "Advances in Protein Chemistry". The existence of excellent annual reviews of this type makes it reasonable to inquire into the purpose in bringing out yet another multi-author multi-volume work. There must be a justification for embarking on as substantial a project as "The Proteins", but it is not readily apparent. Several of the contributions to the present two volumes deal with subjects already covered recently and adequately in "Advances in Protein Chemistry" and, in most cases, the style and presentation are identical with those familiar in this series. It is not

easy, on picking up a volume of "The Proteins" and a volume of "Advances in Protein Chemistry", immediately to know which is which. It would have been pleasant to have had something really new.

It is perhaps appropriate to raise here the question of monographs versus polygraphs. Under the pressure of war-time and post-war conditions, the multi-author book was perhaps inevitable and performed a useful service. In some cases, it reflected the close team-work that had gone into the development of a given subject. But now the scientist is faced with a multitude of 'advances' in this-that-and-the-other, and in addition a succession of polygraphic works of a text-book character. The monograph is becoming a rarity. The undoubted service to science that has been rendered in the past few years by the publication of topical polygraphs could rapidly become a disservice if, thereby, the brilliant individual or mature scholar were deterred from presenting his own thought in his own way in his own book. Nowhere is the need for such a critical *oeuvre synthétique* more apparent than in the field of protein chemistry. Nevertheless, the editors state in the preface to the present work that "It is almost redundant to point out that the subject has become too vast to permit a comprehensive exposition by a single pen". Clearly, there is a divergence of opinion between them and the reviewer on this point. Prof. F. Haurowitz's lucid "Chemistry and Biology of Proteins" (same publishers) shows what can be done in the way of a unified treatment on a more modest scale; on the Napoleonic scale, there is always the example of a Partington before us. A re-examination of relative values in scientific publishing would appear to be overdue.

The first volume of "The Proteins" contains eleven chapters arranged in a sequence which combines logic with readability and the retention of interest. After a statement of the basic methods used in the isolation of proteins by J. F. Taylor, there follows a discussion of their general chemistry by P. Desnuelle. In this chapter, it would have been helpful if the structural formulæ of the *R*-groups of the most important amino-acids had been graphically presented in addition to their names. G. R. Tristram then writes on "The Amino-Acid Composition of Proteins", in which he follows closely his earlier extensive treatment of the same topic in "Advances in Protein Chemistry", Vol. 5 (1949). The numerous tables in this chapter of amino-acid compositions will be most helpful to all workers in the field, particularly as most of them give data in the structurally most significant form of the number of residues per molecule. At this point, there is a departure from purely chemical topics to a discussion of physical methods of investigation. A return is made to further chemical and biological aspects of the subject at the end of the volume.

Barbara W. Low contributes a little masterpiece entitled "The Structure and Configuration of Amino-Acids, Peptides and Proteins". This is a critically written essay of some 150 pages on the achievements of the X-ray diffraction method of analysis to the time of writing. The field is vast and is in a state of active growth. One's humble admiration of the courage of anyone who embarks on the task of writing a comprehensive review of this subject at this time is only matched by one's lively appreciation and positive enjoyment of the skilful way in which Dr. Low has mastered her brief. We are indebted to her as much for an exceptionally lucid presentation as for the highly expert critical ability that is everywhere apparent. One wonders, however, whether it is appropriate in a book of this description to devote space to an account of the basic facts of crystallography and of X-ray diffraction methods, of which numerous descriptions are available elsewhere.

The "Optical Properties of Proteins" are treated by P. Doty and E. P. Geiduschek in a contribution that covers a good deal of ground. The authors set out to discuss the interaction of light—ultra-violet, visible and infra-red—with proteins, and include in their survey photochemical aspects as well as classical optical methods and spectroscopic techniques. The result is successful although one would have welcomed a lengthier treatment of some parts. As it is, the chapter will undoubtedly stimulate interest in the reader and provide him with useful leads for further reading. The light-scattering field, in which Prof. Doty's own contributions have been outstanding, is only briefly mentioned but is referred to again in the next chapter. This is J. T. Edsall's magisterial survey "The Size, Shape and Hydration of Protein Molecules". This is really a monograph of 188 pages which embraces all the useful physical and physico-chemical techniques that have been used to characterize the protein molecule as a whole irrespective of the details of its internal structure. We have come to rely on Prof. Edsall's scholarly guidance in these matters, and this particular contribution of his will be well thumbed for some time to come. It is too much to say that we yet know with certainty and exactness the dimensions of more than a very few protein molecules, and the tabular material in this chapter will no doubt be modified as experimental and interpretational techniques are improved. The many physico-chemical properties of a protein molecule in solution are ultimately dependent on its detailed structure, or some parts of it, as is its biological activity; this final synthesis still escapes us, but at least it now appears to be within our reach. The present difficulties in unequivocally relating structure to function are well treated by R. R. Porter in a thoughtful and suggestive essay, "The Relation of Chemical Structure to the Biological Activity of the Proteins".

The important question of how proteins interact with other proteins, with themselves internally, or with smaller molecules and ions, is treated by I. M. Klotz. F. W. Putnam deals in two reflective chapters with the still imperfectly understood phenomenon of denaturation and with chemically induced modifications of proteins. Here again, the need for a really detailed picture of even one protein molecule is clear. There is, of course, always the humbling possibility, as Dr. G. R. Tristram says, that proteins are not compounds in the strictest sense but are "as many suspect, subject to variation in composition within certain close limits, variations which may be imposed and limited genetically and/or environmentally".

In all the abundant terminology of critico-political disquisition, there is one word used above all others to express disapprobation or disgust—'utopian'. It was perhaps utopian to have expected this first volume of "The Proteins" to be better than it is. Absolute perfection is to be sought more in a work of art than in a scientific text. "The Proteins" is as good as we can reasonably expect and may be better than we, standing on the touch-lines, deserve. The authors, editors and publishers are to be congratulated on a notable achievement.

D. P. Riley

Journal of Scientific Instruments

A Monthly Publication dealing with the Principles, Construction and use of Scientific Instruments. Edited by Dr. H. R. Lang. Vol. 30, 1953. Pp. vii+502. (London: Institute of Physics, 1953.) £5 11*s*.

THE *Journal of Scientific Instruments*, the older of the two monthly publications of the Institute of Physics, is devoted to the principles, construction and use of scientific instruments and is edited by Dr. H. R. Lang, secretary of the Institute. Vol. 30, which covers 1953, is considerably larger than its predecessor and contains three special articles, 129 original contributions, sixty-three laboratory and workshop notes, reviews and notices of new books and descriptions of new instruments, materials and tools. The number of items published under the last-named heading is sixty, compared with thirty-eight in Vol. 29, but the number of notices of manufacturers' publications is reduced to twenty and has apparently ceased to be a regular feature. Not only the standard of the contributions but also the quality of their publication are fully in accord with the general high level that the Institute maintains, the graphs and diagrams being particularly clear.

A glance at the comprehensive subject index shows that almost every branch of physics is represented and that many new instruments suitable for use in physical, medical, engineering and other scientific investigations are described. The authors are drawn mainly from the staffs of university and government research laboratories both in Great Britain and abroad, but several are from industrial organizations. The items of more general interest are a preview of the 1953 British Instrument Industries Exhibition; a description of the 1953 Physical Society's exhibition of scientific instruments; a special article by J. R. Scott, of the Research Association of British Rubber Manufacturers, dealing with instruments for measuring plasticity in the rubber industry; and the text of the lecture delivered by A. C. G. Menzies at the Bournemouth convention of the Institute on May 28, 1953, in which recent developments in applied optics are interestingly described and illustrated.

Flowers of the South

Native and Exotic. By Wilhelmina F. Greene and Hugo L. Blomquist. Pp. xv+208+27 plates. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1953.) 40*s*. net.

THIS account of some of the flowers of the southern States of the United States is intended not for the technical botanist but for the general reader. In pursuit of this objective the text, for which Dr. H. L. Blomquist, head of the Department of Botany in Duke University, has been mainly responsible, is written around the series of illustrations, mostly the work of Mrs. Greene. These illustrations comprise three categories. The first consists of attractive black-and-white drawings featuring more than five hundred and thirty different species, of which the majority are wild flowers and less than a hundred exotics. Most of these are excellent portrayals of their subjects, sufficiently large and detailed to permit of easy recognition. The second category comprises forty coloured illustrations of individual species, while the third consists of fifteen groups in colour, which are the least successful because so many flowers are here associated that individually they are not infrequently too small, and the effect is rather confused; but some of the three hundred flowers in these groups portray in colour species shown more clearly in black-and-white.

The textual accompaniment varies appreciably in character but usually provides data as to habitat, sometimes details which will assist in identification and often information of a miscellaneous character.

This book is, in fact, primarily an annotated picture-gallery of flowers, and many will be glad to possess it for the illustrations alone.

E. J. SALISBURY

The Essentials of Physics

By D. R. J. Wood. Pp. xiv+322. (London: J. M. Dent and Sons, Ltd., 1954.) 16*s*.

IN this book the author has attempted to give a summary of all branches of physics necessary for the advanced and scholarship levels of the General Certificate of Education, a knowledge up to ordinary level being assumed, and he has done a good job. For the student who has followed a systematic course, the book will certainly serve as a useful revision course for memorizing formulæ and learning what the author calls the essentials. One hopes, however, that the book will not fall into the inexperienced hands of any casual student who sees in it a possible short cut to examination success; it may not turn out this way, and certainly the author does not intend the book to be so used.

A lot of the revision is in mathematical form; there are no lengthy descriptions and the author has not wasted any words. Of necessity, a great deal of the work is incomplete, but what has been attempted (one might say the barest essentials) has been done well.

One final suggestion. It might be advisable in a future issue to use the term supersonics for *speeds* greater than sound and ultrasonics for *frequencies* beyond the limit of audibility; this would conform to current practice.

T. M. YARWOOD

Sound

A Physical Text-book. By Dr. E. G. Richardson. Fifth edition. Pp. vii+352. (London: Edward Arnold and Co., 1953.) 25*s*. net.

ALL students of physics will assuredly give a hearty welcome to yet another edition of this very well-known, excellent and authoritative book on sound. Since the first edition was published in 1927 much attention has rightly been focused on this hitherto neglected subject, and through the years Dr. Richardson himself has made notable contributions to its advancement.

The book covers all that a candidate for the pass and honours examinations of British and American universities should require, but the author has not forgotten the needs of those research workers and technicians who are not primarily concerned with examinations. Accordingly, several chapters are included to suit their specialized requirements.

A knowledge of physics and mathematics to first-year university standard and of calculus is assumed, and the mathematical theory given is easy to follow and quite sufficient to enable physical conceptions to be followed.

In this edition a considerable rearrangement of the text is made and a certain amount of new material is added. In addition, copious references are grouped together at the ends of the chapters, and these should be helpful to those who wish to delve more deeply into any topic in which they are particularly interested.

THE 1954 MEETING OF THE BRITISH ASSOCIATION IN OXFORD

By Dr. D. B. HARDEN

THE meeting of the British Association which takes place in Oxford during the week September 1–8 will be the sixth time when the Association has met in that city. The first time that Oxford was the host was in 1832, and the other four meetings have occurred at more or less regular intervals since then —in 1847, 1860, 1894 and 1926. Each one of these has had its own successes and its own value for members who attended, for scientists in general, and for the public at large.

In 1832 the president was Dr. W. Buckland, one of the pioneers of the modern study of geology and archæology, who at that time held the University readerships in geology and mineralogy and was later to become Dean of Westminster—truly an appropriate mixture of church and science for choice as president of the new Association (which had only been founded the year before at York). Yet it is recorded that another churchman, John Keble, did not take so kindly to the Association's visit in 1832 and thought it a pity that Oxford should not only receive "the hodge-podge of philosophers", as he called them, but even give some of them honorary degrees.

The second meeting, fifteen years later, presided over by Sir Robert Inglis, was important not only in itself, but also because of the stimulus it gave to the movement, led by Sir Henry Acland, for the reform and advancement of science teaching in Oxford—a movement that was to lead to the foundation of the new University Museum in the Parks as a centre for scientific research and teaching. Its foundation-stone was laid in 1855 and the building was virtually completed by 1860, in which year, most appropriately, the third Oxford meeting of the Association was one of the first activities to take place within its walls.

This 1860 meeting, with Lord Wrottesley in the presidential chair, saw church and science at greater loggerheads than ever. The new museum—to-day once more to be used for British Association addresses —was (as a tablet on the wall of its west corridor records) the scene of acrimonious debate between Samuel Wilberforce, Bishop of Oxford, and T. H. Huxley and others, in which the honours certainly rested with the scientists.

The 1894 meeting, with the Marquis of Salisbury as president, was a quieter affair and has apparently left little mark behind it, though it attracted a membership of 2,321, which for those times was good but by no means a record. Then in 1926 the fifth meeting, presided over by the Prince of Wales, and with men like Prof. (now Sir John) Graham Kerr, Sir Josiah Stamp and Sir Thomas Holland as sectional presidents, touched a further high peak, with what was then the second highest attendance (3,722) of any meeting in the British Isles, being only surpassed by Manchester's total of 3,838 in 1887. Its memory is still green in the Association's annals, and if this 1954 meeting leaves visiting members equally happy and satisfied with its results, those in the University and in the City who are combining in the task of organizing it need have no complaint and no searchings of heart.

The president this year, Dr. E. D. Adrian, who will speak on "Science and Human Nature", is bound to have an attentive and enthusiastic audience in the Sheldonian, as well as in the Town Hall to which his address will be televised in full. A local television of this kind to an overflow audience was also staged at Edinburgh in 1951, and with outstanding success; but this year will be the first time that the conferment of honorary degrees and the beginning of the president's address at the inaugural meeting will be seen by all television viewers in Great Britain, at the same time as the whole address is being broadcast on sound radio to Britain and overseas. The B.B.C. also hopes to stage a series of television programmes from Oxford on other evenings during the meeting, as well as the usual sound broadcasts.

There will be evening discourses by Prof. W. E. Le Gros Clark on "Reason and Fallacy in the Study of Fossil Man", and by Dr. F. P. Bowden on "Friction", and among the sectional presidential addresses mention may be made of Sir John Cockcroft's to Section A on "Recent Developments in High Energy Physics", Dr. G. R. de Beer's to Section D on "Archæopteryx and Evolution", Prof. J. A. Steer's to Section E on "The Coast and the Geographer", and Sir Mortimer Wheeler's to Section H on "Archæology in Africa". These and other presidential addresses, and the many other papers by speakers in the sixteen sections and sub-sections into which the Association's meetings are now divided, will provide sufficiently varied fare to interest and instruct all the visiting scientists and laymen who come to Oxford for the occasion. Great numbers of them are, indeed, expected, and arrangements have been made to house more than two thousand in colleges of the University, if they so wish, while the remainder can be accommodated in the city's many hotels and boarding houses.

The sectional meeting-rooms will all be in or near the Science Area between Parks Road and South Parks Road; and with small distances separating the sections, those—and they are many—who like to divide their attention between various sections will find it easier to do so this year than in some previous ones. As the reception room is to be in Rhodes House, which is also in South Parks Road, members will find that everything will conspire to encourage them to attend more meetings than ever before.

A number of temporary exhibitions will be staged in the Bodleian Library and in the museums and science departments of the University, and should provide members with many interesting things to see and study, over and above the normal exhibitions of art, archæology, science and bibliography which are on permanent show in these institutions.

On the entertainment side—for scientists like others need time for relaxation, and use it at these British Association meetings to great profit as a chance for meeting old friends and making new ones, and for discussing their work and their problems with one another—there will be the usual series of general and sectional excursions to places of interest in the Oxford district, evening functions in the University Museum and in the Ashmolean Museum, a garden party in Trinity and St. John's Colleges and a subscription dance at the Town Hall, as well as numerous

sectional dinners, private parties and other social events.

It has become the rule of late for the host centre to use the occasion of the Association's visit to produce an up-to-date and authoritative survey of the scientific and natural and human history of its district. The local executive committee at Oxford has charged its publications sub-committee with this task, and the volume, which is being wholly financed in generous fashion by the Delegates of the Clarendon Press, is now well advanced and will provide members with a finely balanced survey which should greatly enhance their understanding and appreciation of what they see and hear during their time in Oxford.

The meeting takes place in Oxford itself, and most, if not all, of the visitors will be accommodated within or not far beyond the modern bounds of the city. But as the contents of the regional survey will emphasize, the real venue of the meeting is the Oxford district, that is, the country between Cotswolds, Chilterns and Berkshire Downs, and it is hoped that not only the excursions but also not a few of the lectures and addresses will enable members to get a picture of the natural and human history, both ancient and modern, of the upper Thames valley. Within that valley are other towns besides Oxford, and these towns, too, are to some, though necessarily to a lesser, extent hosts to the visitors from farther afield. Two of them in particular, Reading and Abingdon, are co-operating directly in one way or another with the University and civic authorities in Oxford in the arrangements for the meeting. It is the wish of all who are concerned in those arrangements that they shall lead to a meeting which will stand comparison with any one of the preceding five visits of the Association to Oxford. If the number of visitors equals or exceeds that of 1926, the success of the 1954 meeting can scarcely fail to be assured.

TOXIC CHEMICALS IN AGRICULTURE AND THEIR EFFECT ON FOODSTUFFS

DURING recent years a wide variety of chemicals has become available for the protection of growing crops or stored food. Thus insecticides, weed killers and fungicides are applied to agricultural crops, fruits and vegetables; chemicals known as 'sprout-depressants' are applied to stored potatoes; other stored foods, such as grain, are fumigated, sprayed or dusted with insecticides. To these must be added the bacterial and chemical preparations used against rats which infest food stores. Substances or preparations having the above functions may be conveniently grouped together as pesticides.

The older pesticides were largely inorganic compounds containing lead, arsenic, copper or other metallic salts; and over the course of time methods have been standardized for the accurate determination of metallic residues, and toxicity studies have led to the proposals (by the Metallic Contamination Sub-Committee of the Food Standards Committee of the Ministry of Food) for upper working-limits for such residues in foodstuffs. The precautions necessary in the use of these older pesticides are by now well established.

This is by no means true of the newer pesticides, which are usually organic chemicals highly effective in small concentrations. They present three distinct, although allied, hazards: to agricultural and other workers responsible for their use on the farm or in the food warehouse; to the consumer of food contaminated by residues; and to domestic animals and wild life—birds and useful insects may be killed and the ecological pattern in an area may be modified. Because of these considerations, the Minister of Agriculture and Fisheries in 1950 took the initiative in establishing a working party, under the chairmanship of Prof. S. Zuckerman, to examine the safety of workers dealing with pesticides; many of the recommendations contained in its report published in 1951 [1] were given statutory authority by the Agricultural (Poisonous Substances) Act of 1952.

The working party was re-established in 1951 jointly by the Minister of Agriculture and Fisheries, the Minister of Health, the Minister of Food and the Secretary of State for Scotland to examine the second phase of the problem, namely, the potential hazards arising from the contamination of food with pesticide residues. The report* now issued gives a concise and authoritative survey of existing knowledge. A third report is being prepared on matters affecting animal and plant life.

Many who have been concerned directly or indirectly with pesticides have commented on the lack of available publications concerning their use in the United Kingdom—in contrast, for example, to the United States, where the various public inquiries[2] have had the merit of providing information for both scientific workers and others interested. The working party affirms the fact that pesticides "can be marketed and used on food crops without any reference to official bodies" and that the many government departments concerned with the problem "have no means of obtaining adequate information about the introduction of new preparations except by the goodwill of the firm concerned". The emphasis placed on the necessity of reducing the "area of ignorance about crop-protecting chemicals" will therefore be warmly welcomed by those scientific workers who believe that the lack of information is one of the legitimate reasons for criticism and fear on the part of certain sections of the general public in Great Britain.

The report includes a valuable seven-page section listing the main compounds used as pesticides, classified according to their chemical constitution; an outline is given of their functions and modes of action. This list includes the rapidly growing numbers of the halogenated hydrocarbons (such as DDT and BHC) and the increasingly important organophosphorus compounds (including 'Parathion' and 'Schradan'). As the working party points out, there is a formidable problem facing the analyst concerned with the identification of many of the newer compounds and with their determination at the low concentrations at which they are likely to occur as residues[3].

A further difficulty arises from the lack of knowledge regarding the mode of action of many of the newer substances. Although much research has been carried out on selective toxicity[4], some of the most effective agents for the control of lower organisms are known to interfere with enzyme systems which form a biochemical pattern throughout a wide range of mammalian and other species. Thus, some of the

* Toxic Chemicals in Agriculture: Residues in Food. (Report to the Ministers of Agriculture and Fisheries, Health, and Food, and to the Secretary of State for Scotland, of the Working Party on Precautionary Measures against Toxic Chemicals used in Agriculture.) Pp. iii + 32. (London: H.M.S.O., 1953.)

organo-phosphorus compounds are able to inactivate the choline-esterase system present in motor nerve endings. Moreover, the pharmacologist is faced with the assessment of the chronic toxicity as distinct from the acute toxicity of the substances under investigation, in that their effects on man may be cumulative.

The working party found that there was no direct evidence of human illness arising from pesticide residues in food; but it expressed the opinion that the situation "is not one which allows of complacency . . . while the present lack of any system of notification makes it impossible to find out what proportion of the food we eat is being treated with these less familiar chemicals, the increasing rate of introduction of new and potentially dangerous compounds indicates that measures need to be taken to ensure that the situation does not get out of hand, and that new materials are not used on a commercial scale until at least a specified minimum of information is available concerning their toxicity, and concerning the residues they leave on foods".

The working party took full cognizance of the importance of restoring public confidence: "Public fears about the dangers of chronic illness from eating possibly contaminated food are hardly going to be allayed by statements that there have been no fatal accidents so far, or that chronic illness is not to be expected because none was observed in experimental rats which over a year or so ate food that had been dosed with the new chemicals used in crop protection. Disquiet will give way to confidence only if the public is satisfied that a constant watch is being kept over the problem, and that every reasonable precaution is being taken to obviate possible risks".

It therefore recommended that some permanent machinery be created in the form of an advisory committee to keep under review all aspects of the problem. This conclusion has been accepted by H.M. Government, which is establishing an advisory committee to include representatives of the various ministries and departments concerned, together with representatives of the Medical Research Council and the Agricultural Research Council. There will be general satisfaction that Prof. Zuckerman has agreed to serve as independent chairman of this new body.

In one section of the report is a detailed discussion of the special problem that has arisen in recent years following the introduction of bacterial rodenticides, which have proved highly effective in the destruction of rats. It is noted that "there is no official control of the varieties of organisms employed, or the methods used for culturing them, for checking their virulence or their use under practical conditions". The bacterial preparations introduce risks over and above those associated with chemicals, in that the cultures contain living organisms which may multiply rapidly under appropriate conditions. Following the recommendations of the working party, it is announced that special consideration will be given by the advisory committee to this problem and that the willing co-operation of the manufacturers is assured.

The working party discussed the importance of the training of the personnel handling pesticides; a part-time course of four years in duration has now been sponsored by the City and Guilds of London Institute[5] and is receiving the full support of industry in London and elsewhere.

Other recommendations of the working party which have been accepted by the Ministries concerned include proposals for the active encouragement of research and also for the encouragement of international co-operation—a matter of special importance in that 60 per cent of British food supplies (including a large proportion of staple foods) comes from abroad. The previous 'history' of such foods is largely dependent on the legislation and the vigilance of the authorities in the country of origin, and it is clear, therefore, that co-operation with such overseas scientific bodies as the Food Protection Committee of the National Research Council of the United States[6] can be of great advantage.

Francis Aylward

[1] Toxic Chemicals in Agriculture: Rep. Work. Party Min. Agric. Fish. (London: H.M.S.O., 1951.)
[2] See *Nature*, **168**, 748 (1951).
[3] Agricultural Control Chemicals, 1950 (Advances in Chemistry Series No. 1. American Chemical Society, Washington, D.C.).
[4] Albert, A., "Selective Toxicity" (Methuen and Co., Ltd., London, 1951).
[5] Syllabus No. 127, Pest Control Course, City and Guilds of London Institute.
[6] *Nature*, **169**, 658 (1952).

SPECIATION OF FISHES IN AFRICAN LAKES

By Dr. E. B. WORTHINGTON

THE complex distribution of fishes and other fauna of the great lakes of Africa has attracted attention for more than half a century. Moore[1] paid particular attention to Lake Tanganyika and propounded his hypothesis of the marine origin of some elements of its fauna. Boulenger[2] straightened out the taxonomy of the fishes as then known. Cunnington[3] assembled the data on distribution, discredited the marine origin for Lake Tanganyika and emphasized geographical isolation as a major factor in the evolution of the endemic forms. Regan, in papers too numerous to specify here, described large numbers of new fishes, especially of Cichlidae, and pointed to adaptive radiation towards different types of food and feeding methods as an important factor in their evolution.

These early investigations have been followed up extensively during the past twenty-five years or so by Trewavas, especially on the Cichlidae, Graham on the fishes of Lake Victoria, Worthington on non-Cichlid fishes of many of the lakes, and Poll on lakes lying wholly or partly in the Belgian Congo. Ricardo-Bertram filled in the picture for Lakes Rukwa and Bangweulu, and more recently new investigations have been published or are in preparation as a result of field-studies by Lowe on Lake Nyasa and the East African lakes and Greenwood on the Cichlidae of Lake Victoria. Brooks has recently reassembled the biological and geological evidence about many of the lakes.

Most of these workers and a number of others, in addition to describing new forms and studying the fishes either in the field or the museum or both, have been greatly interested in how these unique lake faunas came into being and have expressed opinions on the subject of speciation. Indeed, the evidence which these African fishes can give on evolution is so great that some of it is now finding its way into the text-books, and in repetition and summarizing, errors can creep in. For example, some of the results given by Worthington[4] were re-tabulated by Mayr[5] in directing attention to the size and age of the lakes as factors in evolution. In quoting Mayr's table,

de Beaufort[6] remarks, "It is clear that the larger and the *deeper* [italics mine] a lake is, the greater will be the ecological niches where special forms can develop . . .". Reference to the factor of depth is misleading except in relation to age, because work by Beadle on Lake Edward, Damas on Lakes Edward and Kivu, Beauchamp on Lakes Tanganyika and Nyasa, and more recently Capart and his collaborators on Lakes Tanganyika, Edward and Kivu, has shown that the development of a persistent thermo-chemocline at 60–200 metres below the surface is general in the deeper African lakes. Below the thermochemocline, the water is always impossible for aerobic life, through deoxygenation. Thus depth has great importance in relation to the diversity of ecological niches, but not in the sense indicated by de Beaufort. Practically all the water of Lake Victoria, including that immediately above its vast floor, is available to aerobic organisms, because that lake is so shallow that only in special conditions does the bottom water become deoxygenated. On the other hand, the environments available to aerobic organisms in Lakes Tanganyika, Nyasa and Kivu, which are much deeper than Lake Victoria, are limited to a comparatively narrow belt of lake floor, together with the open water in the superficial oxygenated layers.

Size of an African lake is usually related to the diversity of environments, but here again generalizations can be misleading. For example, Lake Rudolph and Lake Albert have relatively monotonous shore conditions with infrequent sheltered bays formed by sandspits or projecting rocky escarpments. Lake Kioga, with a shoreline composed largely by papyrus swamp fringed with lilies, provides a different kind of monotony. By contrast, the drowned valley of Lake Kivu or the vast shallow depression of Lake Victoria provide irregularity of shoreline, leading to greater diversity of shallow-water conditions and hence to a multitude of ecological niches. Factors such as these have been elucidated by the work of the East African Fishery Research Organization, which states[7]: "The examination of a considerable amount of data has led to the conclusion that Lake Victoria should be considered as many lakes within a lake".

A review of the recent literature reveals that one important problem, which is fundamental to modern hypotheses of the mechanism of evolution, remains unsolved, namely, whether sympatric speciation has ever taken place in these African lakes, or whether all the speciation can be referred to allopatric origins. This article is written primarily with that problem in mind, remembering that, according to current genetical hypothesis, the effective prohibition of gene flow between two populations is a necessary prerequisite to speciation.

Much clearly depends on the definition of terms. Sympatric speciation, in its original definition when applied to lakes, implies the multiplication of species within a single lake in the absence of geographical isolation. Allopatric speciation always invokes geographical isolation. Thus Mayr stated that "nearly all the authors who have studied species flocks in fresh-water lakes have come to the conclusion that these species developed by sympatric speciation"; but he concluded that "*bona fide* evidence for sympatric speciation is very scanty indeed". The ideas behind the terms sympatric and allopatric have helped materially to tighten thought on the subject, but, as evidence accumulates and argument is elaborated, the time may soon arrive when they will require a new definition, at any rate as applied to speciation in inland waters.

That geographical isolation has played a very great part in bringing about the present distribution of fishes in Africa is in no doubt—there is so much evidence for this that it is needless to recapitulate—but Mayr stretched the imagination too far when attempting to explain examples of apparent sympatric speciation on allopatric premises. To take one of the more simple examples, he referred to the existence in three separate lakes, Albert, Rudolf and Tanganyika, of pairs of species (or subspecies) of the large predator fishes belonging to the Centropomid genus *Lates*. Of the two forms in each lake, it appears that one inhabits the shallower water and the other the deeper water, the latter being distinguished mainly by having larger eyes and smaller scales. Worthington concluded that the two forms evolved within each lake; but Mayr writes, "Would it not be much simpler to assume that all the lakes were colonized twice by Nile perches, once by a small-sized, deep-water-loving species, and once by a large-sized, shallow-water species?" There are two potent reasons against this explanation: first, the two forms in Lake Tanganyika represent a species-pair distinct from the *Lates* in the other lakes; secondly, it is geologically impossible to assume that there was once a deep-water environment connecting these three widely separated lakes. The evidence points clearly to the original *Lates niloticus* stock, which persists as a river species in the Nile, Congo, Niger, etc., having undergone a degree of speciation which is parallel in the separate lake environments.

One further example of the pitfalls inherent when invoking previous water connexions will suffice. In discussing possible reasons for the greater diversity (in species, though not in genera) exhibited by Lake Nyasa compared with Lake Tanganyika, Mayr wrote: "That Lake Nyasa has more endemics than Lake Tanganyika is probably due to the fact that in its past history it was connected with a greater number of river systems". Trewavas[8], who knows Lake Nyasa well, could not accept this. Indeed, it will not stand for the following reasons. There is little evidence of past water connexions with Lake Nyasa other than the present one to the Zambesi. During periods of desiccation this lake was no doubt completely isolated, but it did not dry up because of its great depth. Lake Tanganyika, with an intermittent connexion to the Congo, likewise did not dry up because of its great depth; but there is clear evidence that at a fairly recent stage it received the addition of water which was formerly part of the Nile system, in consequence of the ponding of the upper Rutshuru River by the Mufumbiro volcanoes to form Lake Kivu, which overflowed southward by the Ruzizi River to Lake Tanganyika. There is, moreover, a ridge in the floor of Lake Tanganyika separating the lake into two deep basins which may have been separate lakes during periods of aridity. No such ridge is known in Lake Nyasa. Thus the evidence is that the confluence of separate rivers or lakes has played a greater part in the origin of fish in Lake Tanganyika than in Lake Nyasa—the reverse of Mayr's suggestion.

Differences of opinion such as those referred to above have generally depended on the assumption that a single lake, even a big one, is one geographical unit and that a species-pair or a species-flock, if proved to have been evolved within that lake, is evidence of sympatric speciation. But the more we

learn about lakes the more complex does the discussion become. Particular ecological niches may be repeated in many parts of a lake, but isolated from each other. Imagine a species adapted to life in a rocky environment giving protection from competitors and predators. The 2,000 miles of coastline of Lake Victoria, as an example, provide plenty of rocky shores, many of them isolated from each other by fifty miles or more of open water or other kinds of coast; similarly, with other types of shoreline such as papyrus swamp, sheltered bay, boulders or exposed sandy beach. A species which is unable, on account of its adaptations, to explore far from its chosen niche may have plenty of scope for becoming genetically isolated from its brethren within the confines of that lake. Brooks[9] developed this argument of 'intralacustrine geography', and among other evidence pointed to the definition by Trewavas of a species of *Haplochromis* from Lake Nyasa as two subspecies from the two ends of the lake. Even the species-pairs of *Lates* referred to above may experience an element of isolation from each other comparable to the altitudinal zonation of birds on mountains.

Thus we reach a revised definition of geographical isolation as including micro-isolation within one lake, as well as macro-isolation in separate lakes. Mayr[10] gave expression to this and it appeared to go a long way towards harmonizing different points of view; but in the same paper, when referring again to African lake fishes, he re-quoted a passage from his earlier work[5] emphasizing the hypothesis of causation of species-flocks by multiple colonizations.

Several of the species-flocks, particularly some belonging to the family Cichlidae, have now been closely examined in their environments. For example, four endemic species of *Tilapia* in Lake Nyasa studied by Trewavas[11] and Lowe[12,13] are adapted to a series of environments from inshore to open water. Although distinct according to habit and habitat, they are by no means easily distinguishable in the museum. It would be far-fetched, indeed, to explain this flock by multiple colonization. The same may apply to the two species of *Tilapia* in Lake Victoria, of which the more abundant and the main article of fish trade from that lake was described by Graham[14], after its identification by native fishermen.

The most outstanding examples of apparent sympatric speciation are to be seen in the large species-flocks of the Cichlid genus *Haplochromis* and related forms. Diversity in this group is so great that each new collection made from about 1900 to 1940 resulted in the description of many new species. The complex could only be sorted out by intensive field-work, and there should be much more evidence about *Haplochromis* in the region of Lake Victoria, Lake Kioga and Lake Edward when Greenwood has completed his present studies. His interim conclusions[15] have already helped by sorting the *Haplochromis* of Lake Victoria into three groups of twenty-four, seventeen and eighteen species respectively, of which group 1 is generalized and groups 2 and 3 show progressive specialization as predators. In relating the evolution of each group to what is known of the tertiary and quaternary geological history of the region, Greenwood concluded that geographical isolation, that is, the division of Lake Victoria into separate entities during its formation and during periods of desiccation, and the confluence of the ancient system of rivers which flowed from the east, played a part in the evolution of groups 1 and 2. But he attributes the evolution of group 3, the more extreme forms of *Haplochromis* predators, to the recent period since the last major interpluvial period; in other words, they have evolved in Lake Victoria as we see it to-day.

It would be very difficult to imagine isolating factors, even of the micro-geographical kind, to account for the speciation of the eighteen members of group 3 of *Haplochromis* in Lake Victoria. Therefore they, together with the *Tilapia* flock of Lake Nyasa and a few other examples, appear to stand as *prima facie* cases of true sympatric speciation, until they can be explained on other premises.

As selective factors influencing the evolution of African fishes, Worthington placed emphasis on lack of competition in the cases of Lake Victoria and Lake Edward, caused by the earlier extermination of a pre-existing fauna by desiccation. The suggestion was that the many empty ecological niches which became available when these lakes were re-formed after inter-pluvial periods of aridity allowed unusual scope for speciation on the part of those few fishes which somehow survived desiccation or gained access to the new lakes. This idea depended on geological evidence of previous desiccation, of which there is plenty; and, if the idea was to fit into the whole picture of African fish distribution, on evidence for the pre-existence in the Lake Victoria–Edward region of a nilotic type of fauna which no longer lives there. When the idea was put forward, miocene fossils of *Lates* had been found in the Lake Edward basin by the Cambridge Expedition of 1930–31, as described by Fuchs[16], but the fossil evidence for the pre-existing fauna of nilotic type in the Lake Victoria basin rested solely on remains of the leathery turtle, *Trionix*. There was, in fact, a considerable element of doubt in postulating the desiccation of Lake Victoria. It is therefore satisfying that Greenwood[17] has now identified *Lates* and also *Polyterus*, another nilotic element which no longer exists in the Nile system above the Murchison and Semliki Falls, from the miocene beds of the north-east corner of Lake Victoria. This new discovery greatly enhances the hypothesis.

The conclusion that predation has had a marked retarding influence on the speciation of the African fishes by eliminating those forms which, in the course of their evolution, passed through stages of inadequate adaptation was also reached by Worthington[18]. Evidence for this came from the fact that those lakes which lack the bigger and more voracious predators, especially *Lates* and *Hydrocyon*, have larger numbers of endemic species than those lakes which contain these predators, when taking other factors, such as probable age of lakes, into account. For example, Lake Nyasa has a greater number of endemic species, but fewer endemic genera, than Lake Tanganyika. The latter is almost certainly the older of the two, and it has an abundance of the large predators, *Lates* and *Hydrocyon*, which are absent from Nyasa. The contention is that, where predators are continually on the prowl, the lesser forms, adapted to their particular ecological niches, can depart from them to colonize new micro-environments or to breed with their neighbours only on pain of death. Mayr would not admit this in his book[5], but recently in conversation was less inclined to rule out the possible influence of predators in certain circumstances. This question appears to have relation to other ideas on stabilizing selection in evolution referred to by Waddington[19].

Kosswig[20] put forward suggestions that specialized feeding and breeding habits have acted as isolating

factors in the speciation of the African Cichlidae. This helps further to an understanding of how genetic isolation has taken place; but as Greenwood[16] remarks, more knowledge is needed about ecology and ethology of the species-flocks before such factors can be defined. Kosswig was making an overstatement when he wrote that "This remarkable phenomenon [Woltereck's 'schizotypische Artaufspaltung'] is characteristic only for the Cichlidae of the East African lakes". Similar though smaller species-flocks are to be found among Mormyridae, Cyprinidae, Cyprinodontidae and other families, and when these groups come to be studied more intensively in the field as well as in the museum, they will surely provide additional evidence of importance.

In assessing the value of different contributions it is, of course, necessary to consider each against the taste of knowledge at the time it was written. Thus it is easy, with to-day's knowledge of African geology, to smile at Moore's hypothesis of the origin of Lake Tanganyika from a Jurassic sea; but Moore's provocative thesis stimulated much work designed to prove or disprove it, and therefore served good purpose. Similarly, some of Worthington's postulates made twenty years ago have been modified by recent work; for example, the relatively short period then suggested for the evolution of some of the modern species-flocks in Lake Victoria and Edward must be lengthened. The development of genetical knowledge and hypothesis has, moreover, given a new view of what is possible or impossible in the process of speciation. There remains, however, a broad field for study in these African lakes; and as piece after piece of the puzzle is fitted in, one reaches a final conclusion, that it is very difficult for the evolutionary biologist to draw sound conclusions on a subject of this sort without field-study, leading to an understanding of the detailed relations between the fish and its environment.

[1] Moore, J. E. S., "The Tanganyika Problem" (London, 1903).
[2] Boulenger, G. A., "Catalogue of the Fresh-water Fishes of Africa" (London, 1909–16).
[3] Cunnington, W. A., *Proc. Zool. Soc. Lond.*, 507 (1920).
[4] Worthington, E. B., *Int. Rev. d. ges. Hydrob. u. Hydrogr.*, **25**, 304 (1937).
[5] Mayr, E., "Systematics and the Origin of Species" (New York, 1942).
[6] de Beaufort, L. F., "Zoogeography of the Land and Inland Waters" (London, 1951).
[7] East African Fisheries Research Organization. Annual Report for 1951 (Nairobi).
[8] Trewavas, E., 13th Congress Intern. Zool., Abstract V, 13 (Paris, 1949).
[9] Brooks, J. L., *Quart. Rev. Biol.*, **25**, 131 (1950).
[10] Mayr, E., *Evolution*, **1**, 263 (1947).
[11] Trewavas, E., *Nature*, **160**, 96 (1947).
[12] Lowe, R. H., "Report on the Tilapia and other Fish and Fisheries of Lake Nyasa" (London, 1952).
[13] Lowe, R. H., *Proc. Zool. Soc. Lond.*, **122**, 1035 (1953).
[14] Graham, M., *Ann. Mag. Nat. Hist.*, (ii), **10**, 209 (1928).
[15] Greenwood, P. H., *Nature*, **167**, 19 (1951).
[16] Fuchs, V. E., *Geol. Mag.*, **71**, 97 (1934).
[17] Greenwood, P. H., *Ann. Mag. Nat. Hist.*, (iv), **12**, 1192 (1951).
[18] Worthington, E. B., "The New Systematics", 287 (ed. J. Huxley) (London, 1940).
[19] Waddington, C. H., *Nature*, **170**, 680 (1952).
[20] Kosswig, C., *Nature*, **159**, 604 (1947).

NEW RADIOCHEMICAL FACILITIES AT HARWELL AND AMERSHAM

THE development of the atomic power programme in Britain has created an increasing demand for scientific and technical work on isotopes of uranium and plutonium. At the same time, production of radioactive isotopes for medical, scientific and industrial use has been increasing rapidly. Several interesting new laboratories providing special facilities for this type of work have recently been opened at Harwell and at the Radiochemical Centre, Amersham.

Radiochemical–Metallurgical Laboratory

A new wing has been added to the Radiochemical Laboratory at Harwell to provide for chemical and metallurgical investigations into the problems of nuclear power production as well as for more basic studies. The new wing, which has a floor area of about 15,000 sq. ft., provides a large main hall 20 ft. high for semi-plant-scale work and for large experimental equipment (Fig. 1); there are also six smaller laboratories for preparative and analytical work, for X-ray diffraction studies on uranium and plutonium compounds and alloys, and for the spectrographic analysis of radioactive materials.

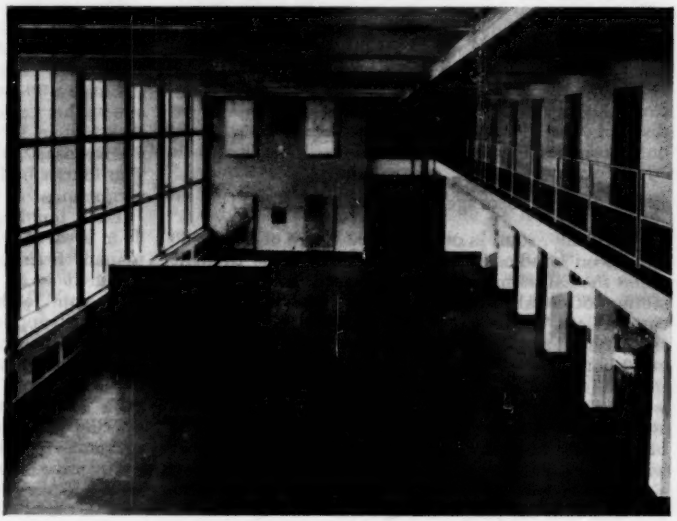


Fig. 1. Extension to the Radiochemical Laboratory, Harwell, showing the main hall with the decontamination room at left background

In addition to a normal workshop, there is also a highly active workshop and decontaminating area which will be operated by staff wearing 'frog suits'. All experiments in the main hall using radioactive material will take place in sealed boxes operated from the outside. Equipment in the boxes will be dismantled only in the decontaminating area.

The new wing has the same clean finish as the main Radiochemical Laboratory, and is provided with the usual services of that building in the overhead floor. In order not to cut down the light of the north wall of the main hall by ventilating ducts, a novel feature is used in bringing the large volume of air necessary to provide ten changes per hour down

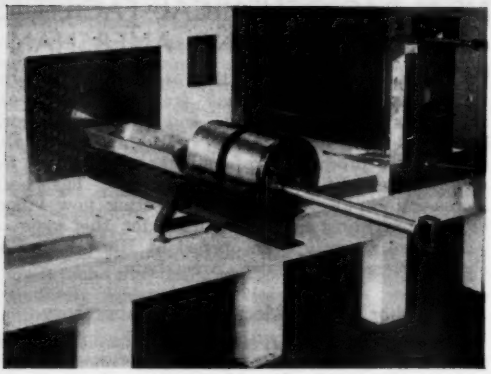


Fig. 2. End face of the storage block and the storage tubes. The irradiation tray has been withdrawn from the tunnel. Note lead shielding plugs to prevent shine. Concrete slabs forming tables are seen and also a section of 4-in. lead wall. A handling tool through a ball joint, a viewer and a can lid-unscrewing tool are attached to the wall

from the service floor between double windows to be discharged at floor level. The extract is then taken out through grilles in the ceiling.

Isotope Storage and Handling Block

Previously, sources of 100–1,000 curies of cobalt-60 have been handled under water, as this was thought to be the safest method. At Harwell, screening and storage of cobalt-60 sources of this activity are now carried out without water, thereby considerably simplifying the handling operations. The storage and handling block provides storage space for several thousands of curies of cobalt and other isotopes (Fig. 2). Various handling cells are built up against the block for easy transfer of sources. The block itself is a cube of concrete 12 ft. × 9 ft. × 9 ft. with a dense aggregate centre through which run sixty steel tubes to contain active isotope cans after irradiation in the pile. Through the centre of the storage tubes runs a tunnel in which may be placed plastics or biological specimens for gamma irradiation from the stored cans.

Around the block run low benches built of dense concrete slabs 3 ft. × 3 ft. × 9 in. The slabs can be used as building blocks enabling any shape of table to be constructed or a slab to be replaced should it become contaminated.

Six cells are built along tables using the standard 4-in. thick interlocking lead bricks to form 3-ft. high walls, through and over which are installed various viewing devices and tools covering a variety of manipulations. Each cell is adapted to meet special needs, including one having walls of lead 8 in. thick, which is used for assembly of therapy sources of several hundred curies from a quantity of active cobalt pellets.

A fuller description of the design will be published shortly by West and Rees.

Radioisotope Processing Laboratories, Radiochemical Centre, Amersham

At Amersham on April 8, Sir Henry Dale opened a group of new buildings which have been specially designed to accommodate plant for producing radioactive isotopes. The very substantial quantity of these materials which has come from Harwell and from Amersham in recent years has mostly been produced in fairly simple apparatus, which has required some direct manual operation, and has been housed in buildings designed for general radiochemical work rather than for production. The demand has now increased so far that for several of the more important isotopes it has become necessary to construct individual chemical plants, which are completely screened and operated entirely by remote control, and to install them in buildings designed for the purpose.

The building scheme provides for eight units, and four of these have been erected so far (Fig. 3). Each building is used for a group of processes of similar character. Thus the separation of the fission products, strontium-90 and cæsium-137, is accommodated in one; the production of iodine-131, phosphorus-32 and carbon-14 in another; and a third is used as a dispensary for radioactive solutions of all kinds. The fourth building will be used to produce labelled compounds by biological methods.

Each building consists of a single room having a floor area of 900 sq. ft., which is clear of any permanent fittings. Each unit is well separated from the next so as to reduce the radiation field between them, and also to allow access for heavy vehicles carrying supplies of radioactive raw materials. The bays will accommodate tankers carrying fission products from Windscale or trucks containing irradiated materials from Harwell. Each building is provided with all the services which are necessary for conducting radioactive processes efficiently and safely—particularly ventilation, and special drainage for radioactive effluent—and these are arranged in groups so as to serve six production units in each room.

Fig. 3. New buildings at the Radiochemical Laboratory, Amersham; the wooden, glass-fronted structures above the entrances house the ventilating equipment for each building

The scheme has been designed by the Ministry of Works to meet the requirements of the Radiochemical Centre, and its erection has been supervised by the Ministry's architects and engineers.

Installation of the chemical production plants has been going on for about six months and is nearly half completed. Five units are now in operation. Processes which have been used hitherto for extracting radioactive isotopes from irradiated materials have not been generally found suitable for scaling-up, and it has therefore been necessary to develop new methods which are basically suited to operation by remote control. Each plant has been designed to meet the general requirements of adequate screening against radiation, avoidance of any direct handling of active materials, and effective control of gaseous, liquid and solid effluent. All equipment which is likely to become radioactive is contained in sealed compartments, and these are screened by walls of lead or concrete bricks; so that in future, if modifications are required, each plant can be dismantled completely without interference with the structure of the building. The level of activity handled in these plants is up to about 100 curies of gamma-emitters.

A further building has been provided as a dispatch department for handling consignments of radioactive materials, which now number more than a thousand each month, and are directed to some forty countries throughout the world.

NATIONAL PHYSICAL LABORATORY, TEDDINGTON

OPEN DAY

AN open day was held at the National Physical Laboratory, Teddington, on May 7, when more than two hundred exhibits, including ninety not previously displayed, were on view. The General Board of the Laboratory held its annual meeting in the afternoon; other guests of the Laboratory, representing industry, the universities and other government departments, numbered twelve hundred.

One of the most spectacular items was a new surge generator demonstrated by the Electricity Division. Rated at 3·2 MV. and 77 kW.-sec., it supersedes a 2-MV., 20-kW. sec. generator which had become inadequate as a result of the trend to increased transmission-line voltages both in Britain and abroad. The new generator has eight stages connected in series by the flashover of spark gaps, and triggering is effected by the injection of a surge at the middle electrode of the first spark-gap. By producing a unidirectional pulse of a duration measured in microseconds, it can closely simulate lightning surges in overhead transmission lines (see *Nature*, May 8, p. 850).

The Light Division has for some time been manufacturing diffraction gratings by a method originally suggested by Sir Thomas Merton. The availability of these relatively cheap gratings of high precision has made possible a most useful device for precise measurement of length, and the Laboratory is collaborating with an industrial firm to apply this principle to the automatic control of machine tools. Two superimposed gratings adjusted so that there is a small angle between their rulings produce fringes at right angles to the rulings similar to the moiré effect of watered silk. When one grating is traversed relative to the other at right-angles to the rulings, the fringes also move but at a greatly magnified rate. The number crossing the field of view is recorded on an electronic counter controlled by a photocell, thus enabling displacements to be measured rapidly with an order of accuracy limited only by the number of lines ruled on the diffraction gratings. The Merton-NPL diffraction gratings are also used in an infra-red grating monochromator for chemical process control. High dispersion and resolution are obtained at low cost using a replica grating with a selective filter, cheap spherical concave mirrors and simple slits. Two models were shown differing only in size and in the type of infra-red detector. The instrument exploits the variation of absorption bands in the infra-red region of the spectrum associated with change of concentration of the sample. The output may, if required, be arranged automatically to control the process.

The Aerodynamics Division demonstrated the continuously running high-speed wind tunnel which can operate up to a Mach number of 2·6. It is being used for measurements on bodies of revolution, with or without wings, and for heat transfer research. The High Speed Group to which this tunnel belongs also specializes in the fundamental problems of flight at transonic and supersonic speeds, particularly to provide data for new theories and to test their validity. Such work can usually be done with very small scale models, but two larger tunnels with working sections of 36 in. by 14 in. (90 cm. by 36 cm.) and 25 in. by 20 in. (63 cm. by 50 cm.), respectively, are under construction and will soon be operating. Among other experiments in progress is one to determine the characteristics of swept-back wings in supersonic flow. Given sufficient sweep-back, the leading-edge conditions resemble those for subsonic flow, and the wing can have a conventional rounded nose. The supersonic performance of such a wing depends critically on the amount of suction occurring at the rounded leading-edge, as this reduces the drag. Existing theory cannot accurately predict the leading-edge flow, and hence the need for experimental measurements of surface wing pressure. Thin-wing sections offer certain advantages in high-speed flight, and experiments are in progress to examine the flow past wings the thickness of which is only 4 per cent of the chord compared with the 8–10 per cent of most current aircraft. Other demonstrations by the Aerodynamics Division included an interferometer for measurement of air density in high-speed flow, and techniques for evaluating base pressures at supersonic velocities. An item of topical interest was the use of an open jet tunnel to determine the best type of funnel for the Royal Yacht *Britannia*.

The Mathematics Division demonstrated a new differential analyser just brought into operation. A machine of advanced design, it transmits all mechanical rotations through electrical servo-mechanisms. It is a highly complex piece of apparatus occupying 4,000 sq. ft. (370 sq. m.) of floor space and containing more than 100 miles (160 km.) of wiring and a thousand electronic valves. The ACE pilot-model high-speed digital computer has been fitted with a 'magnetic drum' store holding 1,024 digits, on each circumferential track of which there will eventually be 128, 32 now being in use. Calculations can proceed while a delay-line storage unit is being filled from a drum so that, despite the relative slowness of the drum system, the overall speed of the machine is

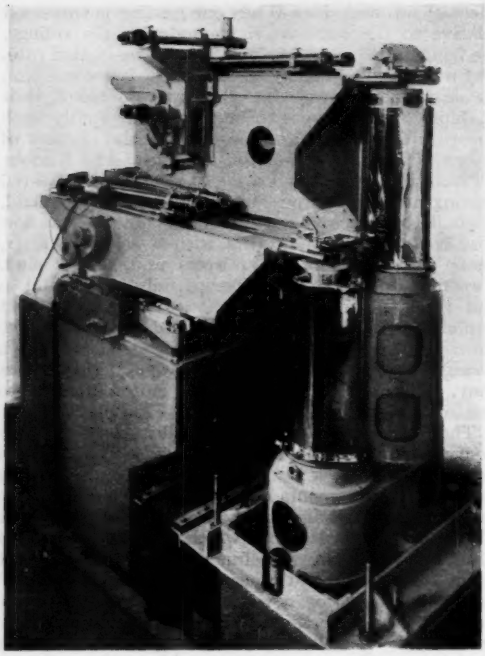


Fig. 1. The new primary standard barometer, range 0–900 mm. of mercury, showing the 'optical probes'

scarcely affected. The magnetic drum store greatly extends the range of application of the machine and makes it possible for partial differential equations to be dealt with in a satisfactory manner.

The Metallurgy Division has opened a new laboratory for research in connexion with X-rays, ceramics and the application of radioactive tracer techniques to metallurgical problems. In the radioactive tracer section, adequate safety measures have been provided both to protect the laboratory workers and to prevent the escape of radioactive material. These measures include a filtered air-conditioning system and a slightly reduced air pressure in the laboratory. The Division has installed a vacuum melting furnace and a water-cooled hearth arc melting furnace, both designed to maintain a high degree of purity of molten metal. The vacuum melting furnace is a high-frequency induction type in which 50 lb. (23 kgm.) of ferrous alloys may be melted and cast *in vacuo* or in a controlled atmosphere. Dried hydrogen can be circulated around the system and finally blown on the surface of the molten metal to de-oxidize it. The water-cooled hearth arc furnace can melt up to 2 lb. (1 kgm.) of metals too reactive to be melted in refractory crucibles (for example, titanium). The hearth, of copper, is water-cooled and is heated by an arc struck between a tungsten-tipped water-cooled electrode and the metal resting on the hearth. The furnace can be evacuated but is usually operated with an argon atmosphere. This equipment will assist in the researches on titanium alloys which are being developed by the National Physical Laboratory. These alloys are particularly useful for the manufacture of components of gas turbine compressors, for they are satisfactory at temperatures up to 400° C., so bridging the gap between aluminium alloys and heat-resisting alloys. Two new measuring techniques were demonstrated: one a high-temperature extensometer for use up to 1,400° C., and the other a strain recorder employing a movable soft-iron transformer core as its sensitive element. The latter device has a large range for a given sensitivity, and fracture of the test-piece will not damage the instrument.

The Ship Division has developed a new dynamometer suitable for determining the performance of yachts under sailing conditions. It measures the principal forces and moments acting on a yacht model while it is effectively under sail. From the data obtained, the speed made good against the wind in the 'close hauled' condition can be determined to compare the merits of different designs. The hydraulic circuit of the water tunnel, used by the Ship Division for propeller research, has been modified, and the drive to the test propeller increased in power. Experiments with larger models over a wider range of screw operating and cavitation conditions can now be carried out. A merchant ship propeller designed to delay the inception of cavitation was demonstrated.

The Metrology Division exhibited a new primary-standard barometer capable of measuring, from first principles, pressures covering the entire range found in free air, that is, 0–900 mm. of mercury (Fig. 1). The instrument employs a new 'optical probe' enabling the position of each mercury surface to be assessed to $\pm 0{\cdot}001$ mm. This probe comprises two similar telescopes rigidly set at a small angle so that their axes intersect a suitable distance in front of them. One telescope projects the image of an illuminated optical grating on to the mercury surface, from which it is reflected back into the other telescope, where it is superimposed on an identical grating. Coincidence of the images, which is determined photoelectrically, implies that the apex of the probe is in the plane of the mercury surface. This device permits superior water-jacketing of the mercury with consequent improved thermal control, and it is anticipated that the technique will have other metrological applications.

Three new comparators have been designed for the determination of the internal diameters of reference rings to an accuracy of 0·00001 in. ($\pm$ 0·25 μ). Two of these work in the ranges of 0·1–3 in. (2·5–76 mm.) diameter up to 3 in. (76 mm.) depth and 1·5–6 in. (38–152 mm.) diameter up to 12 in. (305 mm.) depth, respectively. Both these instruments compare the ring diameter with a reference standard of box form built up from high-precision slip-gauges and end-plates. The third instrument is a pneumatic comparator covering a range of 2–6 in. (51–152 mm.) diameter. An interesting device to speed-up the reading and tabulation of points from records or graphs has been built. A spot of light is brought by an operator to the required point on the record, and, on pressing a button, the reading is automatically typed. Simple adjustments allow the zero point to be set and the scale stretched or compressed. The present reader works only in one dimension, but a two-dimensional version is under construction.

The Test House has developed a new thermometer test bath for the rapid inter-comparison of liquid-in-glass thermometers in the water temperature range. Up to seventy-two thermometers can be checked while totally immersed in water, the temperature of which can be varied at will. The operator reads the thermometers through short-focus binoculars.

The Physics Division has recently commenced the examination of the properties of gases of importance to chemical and mechanical engineers. Very accurate experimental work is necessary firmly to establish the theoretical methods used to study these properties, particularly at high pressures and temperatures, and this led to the introduction of a development programme in the field of high-pressure physics. As part of this programme the Laboratory has undertaken to establish standards of measurement for high pressure hitherto unavailable in Britain. Research is in progress to determine the narrow-beam and broad-beam absorption data for high-energy X-rays. A Van de Graaff generator producing X-rays at a potential of 2 MV. is used, and data are being determined for lead, concrete and barium concrete. The Division continues its highly accurate determinations of the heats of combustion of pure organic substances in co-operation with the Chemical Research Laboratory, which is also at Teddington.

OBITUARIES

Sir John Blake

THE death of Sir John L. Blake, Comptroller-General of Patents, Designs and Trade Marks, occurred with tragic suddenness on May 18 in Paris, where he was taking part in an International Conference on Copyright, organized by Unesco.

Sir John Blake was born in Watford in January 1898. He was educated at Watford Grammar School and then entered University College, London, as a student of physics and mathematics. During the First World War he served in the Royal Navy and in the Royal Naval Air Service and was present at the raid on Zeebrugge. After demobilization he returned to University College and graduated B.Sc. with first-class honours in 1920. In 1922 he was awarded the degree of M.Sc.

He entered the Patent Office as an assistant examiner in August 1920 and became an examiner in 1925. In 1937 he was awarded a Commonwealth Fund Fellowship which entitled him to undertake a year's study in the United States. He spent most of this time in the United States Patent Office and acquired a considerable knowledge of American patent law and practice which was an asset to him in after years.

During the Second World War he served as a principal in the Ministry of War Transport and was mainly concerned with convoy arrangements and the allocation of merchant ships to ports of discharge in the United Kingdom. He returned to the Patent Office at the beginning of 1944 on being promoted to the rank of superintending examiner. In that year also he was called to the Bar at Gray's Inn. He was appointed to be an assistant comptroller in June 1946 and he became comptroller in February 1949, when Sir Harold Saunders vacated that post on being appointed to the Monopolies and Restrictive Practices Commission.

In 1949 a Bill to amend the Patent and Designs Act, embodying most of the recommendations in the final report of the Swan Committee which had been appointed by the Board of Trade in 1944, was in course of preparation. Sir John Blake's initial task as comptroller was to assist in the drafting of the Bill and in discussing the varied questions which arose during its passage through Parliament. The Bill was presented in the House of Lords in May 1949 and received the Royal Assent in July. It was followed by two consolidation acts, the Patents Act, 1949, and the Registered Designs Act, 1949, both of which became operative on January 1, 1950.

Soon afterwards Sir John was faced with the task of acquainting himself with another part of the activity of the Patent Office of which he had little or no previous experience, namely, the intricate matter of copyright. He applied himself to this task with characteristic zest and intensity, and within a very short time he became an acknowledged authority on the subject. He was a member of the Copyright Committee appointed by the Board of Trade in 1951 under the chairmanship first of the Marquess of Reading and afterwards of Sir Henry Gregory. The Committee presented its very comprehensive report in July 1952.

He represented Great Britain at a number of international conferences both in Europe and the United States, on patents, copyright and related matters, and earned the admiration and respect of the representatives of other countries by reason of his profound knowledge of the subjects under discussion, his unfailing tact and courtesy and his ability to reconcile the views of others with his own.

He was awarded a knighthood in the New Year Honours in 1952, and later in the same year he received an additional distinction by being elected to a fellowship of University College, London. His death is a sad loss not only to the Patent Office but also to the professional and other bodies outside the Office with whom his work brought him into contact.

J. N. BROWN

Prof. Paul Selényi

DR. PAUL SELÉNYI, a well-known Hungarian experimental physicist, died suddenly at the age of sixty-eight at Budapest on March 21, after a year of protracted ill-health. He was a pupil of Lorand Eötvös in Budapest and was devoted to his memory throughout his life; he completed a biography of Eötvös shortly before his death.

Selényi's most fundamental contribution to physics dates back before the First World War. By an ingenious method, using a fluorescent coating on a total reflecting prism, he demonstrated the coherence of light rays emitted in nearly opposite directions from this fluorescent light source. His experiment evoked immediate appreciation and remains one of the fundamental experiments of wave optics.

The first anti-Semitic wave in Hungary in the early 'twenties cut across his scientific career. He was forced into second-rate industrial work; he suffered financial hardship and lost his first wife. However, he soon joined the leading industrial research laboratory of the country, then newly founded, that of the Tungsram electric lamp factory, under the leadership of the late Prof. I. Pfeifer. Here he had ample opportunity to show his extraordinary skill in experimental physics. There was scarcely a problem of vacuum technique, lamp technology or photometry he did not help to solve. He always preferred simple experimental arrangements to elaborate apparatus, and he never gave up scientific research. Photocells and barrier-layer cells were among his favourite apparatus. For many years before and during the Second World War he worked on an invention of his, named electrography, which could have served as a basis for picture transmission

and perhaps even television. A grid-biased stream of negative gas ions was made to write invisible negative tracks on an insulator and was developed with fine powder, in analogy to the well-known Lichtenberg figures. The cathode ray tube gave a different turn to television; but perhaps Selényi's contribution will come into its own one day, especially for projection before a big auditorium. He lost his post under the Nazi regime; but he continued to work very successfully on selenium rectifiers.

Selényi's only son, a gifted chemist, was deported by the Nazis, and failed to return; his adopted son, a son of his deceased brother, suffered the same tragic fate. Selényi never recovered from these blows, though he was eventually re-installed as professor in his old University Institute, was elected corresponding member of the Hungarian Academy of Science and was accorded the esteem he so fully deserved.

He was of an extremely kind, sensitive nature, a born teacher; and all who had the privilege of being his pupils and friends are deprived by his death of a man whose friendship, character and advice never failed us. He loved to read poetry and wrote some verses in his spare time; he was a skilled amateur in pencil-drawing and water-colour. Our sympathy goes out to his wife and companion, Dr. Selényi-Greiner, who survives him.

Francis Kőrösy

NEWS and VIEWS

Physics at Bristol: Dr. F. C. Frank, F.R.S.

The University of Bristol has appointed Dr. F. C. Frank to a third chair of physics in addition to that already held by Prof. C. F. Powell and that to which Prof. M. H. L. Pryce will take up his appointment on August 1. Dr. Frank, whose present position is that of reader in physics in the University of Bristol, took his first degree in physical chemistry at Oxford. His subsequent experience of research was at that University, at Berlin under J. W. P. Debye, and at Cambridge under Sir Eric Rideal; during the Second World War he was deputy to R. V. Jones at the Air Ministry. In 1946 Dr. Frank joined the H. H. Wills Physical Laboratory, Bristol, as a research Fellow in theoretical physics, his work being mainly on dislocations, plastic flow of solids and on crystal growth. In 1949 he formulated the now well-known spiral theory of crystal growth, and then undertook the direction of a group of experimental workers whose investigations were suggested by the theory, and which have in many ways confirmed and extended it. The importance of this work has been recognized by his recent election to the fellowship of the Royal Society.

Textile Technology at Leeds: Dr. C. S. Whewell

Through the generosity of the firm of Courtauld's, Ltd., and an anonymous industrial donor, the University of Leeds has been able to build a new building to be devoted to the study of rayon and synthetic fibres, which should be completed in a little more than a year's time. In the meantime, the University has instituted a chair of textile technology, in addition to the existing chair of textile industries (Prof. J. B. Speakman, head of the Department) and the research chair of wool textile engineering (Prof A. H. Nissan), and the new occupant, who will take office in October, will be Dr. C. S. Whewell, at present reader in textile finishing in the University.

Dr. Whewell has spent almost his whole career in the University of Leeds except for a short period in 1936 as a research chemist to the Wool Industries Research Association. He graduated in chemistry in 1933, gaining his Ph.D. two years later, and has held a Clothworkers research fellowship. In 1937 he was awarded the Worshipful Company of Dyers' Research Medal. In the same year he began his teaching career in the University, being successively research assistant in textile chemistry, assistant lecturer in cloth finishing, lecturer in cloth finishing and textile chemistry, and finally in 1948 reader in textile finishing. Dr. Whewell has published numerous papers and articles on the chemical aspects of the finishing of all-wool fabrics and fabrics containing mixtures of wool and man-made fibres, much of his work being carried out with outside organizations. In 1954 he was awarded the Institute Medal of the Textile Institute "for distinguished services to the textile industry in general, and to the Institute in particular".

Kelvin Medal Award: Dr. C. J. Mackenzie, C.M.G., F.R.S.

The Kelvin Medal for 1953 has been presented to Dr. C. J. Mackenzie, president of Atomic Energy of Canada, Ltd., and former president of the National Research Council of Canada (see *Nature*, **169**, 1037; 1952). The Medal was created to mark the great work done by the late Lord Kelvin and is awarded triennially as a mark of distinction to engineers and men of science whose work is of a kind with which the late Lord Kelvin was identified. The award is made by a committee consisting of the presidents of the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, Naval Architects, Mining and Metallurgy, Mining Engineers, Engineers and Shipbuilders in Scotland, and the Iron and Steel Institute.

Joint Science and Industry Committee

The Royal Society of Arts, the British Association for the Advancement of Science and the Nuffield Foundation have established a joint Science and Industry Committee to investigate the possibility of speeding up the application to industry of the results of scientific research. From the 'Conditional Aid' funds the Board of Trade has made a grant to this Committee to help it to begin research into the whole problem. The British Association originally set up a committee to consider this matter, but after preliminary investigations, it was decided to seek the co-operation of other bodies in sponsoring a study of the many problems involved. The new joint committee is well aware that work is already going on in the universities and in industry; nevertheless, terms of reference, which have been accepted by the Board of Trade, are comprehensive. They include the making of a systematic and scientific appraisal of the whole problem, surveying the research already under way elsewhere in order to see what further study is needed; the identification of those factors which determine, in different industries and in different types of firms, the speed of application of new scientific and technical knowledge; the examination of their relative importance, their interrelations, and their correlation with the characteristics of the firm

or industry; the collection of evidence of the effectiveness of measures already taken to speed up the application of science in industry, or to remove hindrances to such application; and the examination of the possible results of other proposed measures. Work is already in progress and centred on two research units; one at the University College of North Staffordshire directed by Prof. B. R. Williams, and one at The Queen's University of Belfast, directed by Prof. C. F. Carter.

The chairman of the Committee is Prof. C. F. Carter, professor of applied economics in The Queen's University, Belfast. Other members are: Sir Ernest Goodale, Mr. A. C. Hartley, Dame Caroline Haslett, Sir John Simonsen (appointed by the Council of the Royal Society of Arts); Dr. T. E. Allibone, Mr. M. G. Bennett, Prof. A. J. Brown, Prof. C. F. Carter, Mr. A. C. Hartley, Prof. K. S. Isles, Prof. H. D. Kay, Prof. J. A. L. Matheson, Dr. R. E. Slade, Prof. M. Stacey, Prof. B. R. Williams, Dr. T. Wilson (appointed by the Council of the British Association); Prof. A. K. Cairncross, Dr. Barnes Wallis, Mr. A. H. Wilson (appointed by the Trustees of the Nuffield Foundation). The secretary of the Royal Society of Arts, the secretary and assistant secretary of the British Association, and the director and assistant secretary of the Nuffield Foundation attend *ex officio*.

University Physics in Great Britain

IMMEDIATELY following the annual general meeting of the Physical Society held on May 25 at the Royal Institution, Prof. R. Whiddington, the retiring president, delivered his presidential address entitled "Physics in the University and the Nation". Prof. Whiddington compared the conditions which existed in university physics laboratories fifty years ago with those to-day by referring to his own experiences as an undergraduate at St. John's College, Cambridge, and later as a research student at the Cavendish Laboratory. Conditions, he said, are very different to-day, in many respects for the better. There are more workshop, technical and secretarial assistance, more apparatus and more adequate maintenance for the research worker himself, but in one direction Prof. Whiddington thinks progress may have gone too far. The young research worker needs to learn from his mistakes; but nowadays with team-work, efficient organization and constant supervision, there is an unfortunate tendency for the research worker to be pulled up and set on the correct path before he has an opportunity of making a mistake. Turning to the present-day problem of the supply and demand of physicists, Prof. Whiddington stated that the recent rapid post-war expansion of the university undergraduate population has not drawn in any more really first-class men than formerly. There is not, as some people believe, an unlimited reservoir of high-grade brains of the academic type on which the nation can draw. The average student, the well-trained physicist, who requires close supervision and coaching rather than the suggestion and leading of the first-class man, is of great importance and value in the modern world and is in increasing demand. However, the supply of these is not getting better, but is actually now being threatened.

The basis of the danger is the shortage of physics schoolmasters and the consequent lack of good teaching in the schools. It is not possible to conjure up suddenly a supply of teachers, but Prof. Whiddington suggested that it may be possible to increase the number of available well-trained graduates by making fuller use of reserves of teaching power. For example, it should be made possible and attractive for the older teachers to continue their work beyond normal retirement age, and to allow and encourage some of the better young physicists now fully engaged in industry or government service to devote some of their time to teaching in the schools. If, Prof. Whiddington finally warned his audience, more science teachers cannot be obtained, and if the partial remedies he suggested proved impracticable, then to ensure an adequate supply of physicists for the national needs, the universities will be forced to take a step backwards, reintroduce a four-year course and face up to the prospect of large numbers of elementary students; the consequence will be a weakening of standards and, without increased accommodation, a reduction in the annual output of graduates.

The Need for Education in British Industry

THE president of the Federation of British Industries, Sir Harry Pilkington, gave an address to the annual general meeting of members in the Eastern Region at Cambridge on May 19, in which, after stressing the necessity for a further ordered advance in the national economy of Great Britain and for keeping prices down by eliminating waste, mechanizing and creating new demands, he referred to the bearing of the shortage of science teachers on technical efficiency. We can only keep the lead in science and in research, he said, by marrying industry and education much more closely. There are still not enough trained minds for our expanding needs, and he specially stressed the importance of good teachers of science: if we cannot get them, we shall be really short of students as well as of graduates within a generation. Sir Harry urged members to give thought to the provision of personnel management, particularly at the technical level, and to the sympathetic absorption of technical recruits. One way of overcoming the shortage of science teachers could be by offering them rewarding work during the vacation; he suggested that firms might allow members of their staff to lecture in technical colleges and schools and provide short-term vacation courses for both students and teachers, and he urged the absolute necessity for education and industry to go forward in co-operation.

Institute of Professional Civil Servants

THE annual report of the Institution of Professional Civil Servants for the year 1953 (pp. 40; obtainable from the Institute, London; 1954) is largely concerned with the details of salary negotiations with the Treasury. Apart from an indication of the broad lines of evidence submitted by the Institution to the Priestley Commission on the Civil Service, set up in 1953, the major effort of which is to secure salary scales which represent a proper alignment between the professional, technical and scientific Civil Service, on one hand, and the administrative, executive and clerical Civil Service on the other, the main interest of the report for the scientific worker lies in its account of the steps taken during 1953 towards parity between the scientific classes and the executive and administrative classes. Substantial success was achieved in establishing parity between the experimental officer and the executive officer classes, but difficulty was created in pressing the claim of the scientific officer class for parity with the administrative class by the refusal of the Treasury to allow arbitration in respect of grades above the limits set

by the Arbitration Agreement. The report expresses regret that the staff side of the National Whitley Council has decided not to give evidence to the Priestley Commission on general pay issues, but to leave each organization to state its own views.

The outstanding question appears to be whether the Priestley Commission will give the Civil Service the long overdue examination, and its importance was stressed by the president of the Institution, Sir Richard A. S. Redmayne, in opening the annual delegate conference of the Institution on May 24. Sir Richard claimed that the Civil Service owes its position to its capacity to attract men and women of first-rate ability, and referred to the statement of the Macdonald Commission in 1914 that it was an accepted principle with all parties that the Government should be a model employer. Now, in its evidence before the Priestley Commission, the Treasury claims that the comparison should be with the current rate paid by the generality of outside employers to staff engaged on comparable work, and Sir Richard quoted evidence that, in consequence, the Civil Service is failing to obtain the recruits it requires, for example, as inspectors of mines and technical engineers. These remarks on the importance of maintaining a first-rate Civil Service were endorsed by the general secretary, Mr. S. Mayne, in presenting the annual report, who claimed that the evidence and proposals submitted by the Institution to the Royal Commission were a considered and constructive contribution, not only to the needs of the Civil Service but also to national needs. Mr. Mayne also commented on the question of civil rights, and his speech indicated the concern with which the attempt to reach a reasonable compromise between security and civil liberties in the Atomic Energy Authority Bill is being followed.

Radiation-suppressing Coatings for Metals at Elevated Temperatures

A description of an investigation undertaken to develop a refractory coating of low thermal emissivity which could be applied to alloys used in gas-turbine construction and which would withstand the severe operating conditions involving thermal shock and vibration encountered in certain parts of such mechanisms is given in Special Report No. 1 of the Fulmer Research Institute, Ltd. (pp. 24+ plates. Stoke Poges: Fulmer Research Institute, 1953; 15*s*. net). The method described previously by the authors, Dr. A. H. Sully, E. A. Brandes and R. B. Waterhouse (*Brit. J. App. Phys.*, **3**, 97; 1952), was used to measure the emissivities of the metal surfaces of 'Nimonic 75', Vickers 'Staybright *FDP*' stainless steel and 'Immaculate *V*' in the three initial conditions—shot blasted, buffed and rolled—at temperatures up to 800° C. without prior oxidation and, after oxidation in free air, to still higher temperatures. For the refractory materials, thoria, mullite, fused silica, zircon, cordierite, aluminium titanate, alumina and magnesia, the measurements were made up to 1,300° C., and the variation of emissivity with particle size, and with thickness, of refractory coatings applied to various metal surfaces was investigated. Methods of bonding the coatings and the results of fatigue, thermal shock and other tests to determine the behaviour under simulated service conditions are also described. It is shown that certain coatings, which can be applied to 'Nimonic 75', and with the use of a protective enamel undercoat also to stainless steel and to mild steel, are capable of reflecting a high proportion of incident radiation and, when correctly applied, can withstand vibration and thermal shock without loss of adhesion to the basis metal. They are potentially suitable for application to any metal parts of engines, furnaces, etc., which are undesirably heated largely by radiation.

A Scholastic Flora

Floras of well-known localized areas command not only their own special contemporary interest; they may also have future value as the landscape changes under the impact of new developments. In a small book, "Flowers and Ferns of Harrow" (Harrow School Natural History Society, 1*s*.), Raymond Harley, aged eighteen and still a pupil of the famous school, has attempted to record as completely as possible the flora of a country area which, like so many others, is in the course of being urbanized. This is a laudable and useful effort. It makes available to the interested inquirer, especially if he be an amateur, the botanical and common names, and the locality and time of flowering of the plants that are to be found truly wild, or as escapes, casuals, or naturalized, in an area of historical interest. Nomenclature and general information are based on the recently published "Flora of the British Isles", by Clapham, Tutin and Warburg, and the text is illustrated by some original drawings which would do credit to a book by a more senior botanist. In the author's view, though the flora of the area is "curiously incomplete", it yet yields species of considerable interest, such as the rare alien *Petasites japonicus*. The author is to be congratulated on this modest but finished piece of work. It would be no bad thing, in the educational and æsthetic interest, if other schools were to emulate this interesting effort.

Protein in Developing Root Cells

The compositions and quantitative relations of protein and related fractions in developing bean root cells have been investigated and discussed in some detail by C. Morgan and W. S. Reith (*J. Exp. Bot.*, **5**, 119; 1954). The amino-acid composition and the quantitative levels of the free amino-acid, protein and peptide fractions at different distances from the root apex were examined by techniques which are described. They have found that as the cell grows there is a threefold increase in protein, a tenfold increase in free amino-acids, and a twentyfold increase in peptides. Simultaneously, the amino-acid composition of each fraction also probably changes. Further, it has been found that various fractions from the meristematic zone yield on chromatograms a variety of ninhydrin-reacting substances which have not been found in detectable amounts in extracts from other regions.

Indoleacetic Acid and Sugar Absorption

In an investigation of the effect of indoleacetic acid on the absorption and assimilation of sucrose by carrot slices, Husein Sa'id and M. I. Naguib (*Proc. Egypt. Acad. Sci.*, **8**, 75; 1952) have observed that the inversion of sucrose was not affected by indoleacetic acid but its uptake and utilization were stimulated, as also was the respiration. Additions of indoleacetic acid stimulated the rapid depletion of the total sugar content of the carrot slices, the inference being that it was mainly utilized in the formation of soluble organic nitrogen at the expense of the nitrate-nitrogen content of the slices.

Regional Survey of Croydon and District

THE Croydon Natural History and Scientific Society commenced in 1913 a regional survey of Croydon and district. The first fruits of this task were published in 1936, as an atlas consisting of a number of maps prepared by members, in a loose-leaf binder. Since then, several further parts have been issued, the latest being the fourth, while a fifth is in preparation. The new part contains a hand-coloured reduced facsimile of the rare first geological map of Surrey (William Smith, 1819), a chart of the Glacial Period, and a map showing the distribution of Iron Age sites and finds in the Croydon district. Each item is accompanied by a sheet of explanatory text, and there is also a note on the Roman occupation of the district. The members of the Society deserve congratulations both for their original concept and the way in which it is being carried out. The chairman of the Regional Survey Committee is Mr. C. C. Fagg, 58 Birdhurst Road, South Croydon, Surrey.

Frank B. Jewett Fellowship Awards

THE American Telephone and Telegraph Co. has awarded five Frank B. Jewett fellowships, as follows: Dr. Stanley Deser, a graduate of Brooklyn College and of Harvard University, for research on the quantum field theory, specifically meson processes, at the Institute for Advanced Study, Princeton; Thomas Fulton, a graduate of Harvard University, for the investigation of problems in theoretical nuclear physics and the quantum theory of fields; Stanley L. Miller, a graduate in chemistry of the University of California, for the continuation of his research at the University of Chicago on the preparation of organic compounds by an electric discharge through a mixture of hydrogen, methane and ammonia, in an attempt to imitate possible conditions in the early history of the earth; Dr. Roger G. Newton, a graduate of Harvard University, who as a Jewett Fellow last year at the Institute for Advanced Study, Princeton, has been investigating the problem of a connexion between the quantum field theories and detailed behaviour of nuclei and their effect on surrounding electrons, and plans to do research on high-energy approximations in the quantum field theory; Dr. Richard Scott Pierce, a graduate of the California Institute of Technology, who was working last year as a Jewett Fellow at Harvard University on the analysis of automata and lattice-ordered rings, and plans to continue his work on the mathematics of automatic machinery and algebraic studies with applications to topology and analysis. These fellowships, which are awarded by a committee from the Bell Telephone Laboratories, are given for research in the fundamental physical sciences by those who have recently received a doctorate or are about to receive one. The stipend is 4,000 dollars to the recipient and 1,500 dollars to the institution at which he elects to conduct his research.

Congress on Photobiology at Amsterdam

THE Comité International de Photobiologie, formerly known as the Comité International de la Lumière, will hold a congress in Amsterdam at the Koninklijk Instituut voor de Tropen, 63 Mauritskade, during August 23–28. The aims of the Committee are the stimulation of scientific research in the physics, chemistry and climatology of ultra-violet, visible and infra-red radiations as they pertain to biology and the study of the effects and applications of these radiations in biology and medicine. At present there are three sections, with presidents as indicated, covering the following branches of the subject: medicine (Dr. A. L. de Groot, of Rotterdam); biology (Dr. J. B. Thomas, of Utrecht); and the physics, chemistry and climatology of radiation, including methods of measurement (Prof. B. Rajewsky, of Frankfurt). Discussions will be held on a sectional basis, and, in addition to the above three sections, others may be formed at the congress if the papers warrant it. There will also be three general symposia during the congress as follows: photoperiodism in plants and in animals; the effects of non-ionizing radiation on genetic elements of cells; and the fundamental effects of non-ionizing radiation on skin. The official language of the congress will be French, but English and German will also be used. Application forms and further information can be obtained from the secretariat of the congress at the Radiologisch Laboratorium, Wilhelminagasthuis, Amsterdam.

Surface-Active Detergents: Congress in Paris

A CONGRESS on surface-active agents and detergents, organized by the French body known as 'Tramagras' with the help of the Institut des Corps Gras and other professional associations, will be held in Paris at the Sorbonne during August 30–September 3. The congress is under the auspices of the United Nations Food and Agriculture Organization, and is intended to bring together persons from all over the world who are interested in the subject. The official languages will be English and French, though translating services and other assistance will be provided for those unable to express themselves directly in either of these two languages. The congress will discuss the scientific, technical, industrial and economic aspects of the subject, and it is hoped to establish a permanent international committee to maintain the exchange of information and to organize further congresses. There are various forms in which persons may participate in the deliberations, the simplest being as an associate member (3,000 francs) or active participating member (5,000 francs). Those wishing to participate must enrol before June 15, application forms and further information being obtainable from the secretariat of the congress at 70 Champs-Elysées, Paris 8e.

Announcements

THE following appointments have been made in The Queen's University of Belfast: N. Stephens, to be lecturer in geography; E. R. Redfearn, to be lecturer in biochemistry; A. G. Smith, to a senior research post in the Department of Botany to work on Quaternary ecology; Dr. B. L. Moiseiwitsch, to be a supernumerary lecturer in applied mathematics.

THE firm of Quickfit and Quartz, Ltd., of Stone, Staffs, has presented £50 to Norwood Technical College, London, to provide an annual £2 prize for the best student of advanced chemistry. This money has been given in recognition of the work of Dr. J. T. Stock and Mr. M. A. Fill, both of the College, who have designed a miniature organic chemistry laboratory (see *Nature*, April 17, p. 715), now being made by the firm.

IN the article entitled "Mechanism of Anionotropy" in *Nature* of May 8, p. 863, Fig. 1, the legend on the abscissa should read "Time (10^3 min.)" instead of "Time (min.)".

THE BOROUGH POLYTECHNIC, LONDON

NEW EXTENSION BUILDING

THE new extension to The Borough Polytechnic, which has been erected by the London County Council at a cost of nearly a quarter of a million pounds, marks a further stage in the post-war provision for higher technological education in the London area. The Borough, like other London Polytechnics, came into being towards the end of the past century, receiving endowments and financial aid made available as the result of legislation consolidating certain London charities—the City of London Parochial Charities Act (1883).

The Polytechnics are distinct from the technical colleges owned by the London County Council in that they possess their own legal identities with their own governing bodies and enjoy a considerable measure of autonomy. They have, however, for many years received grants from the London County Council, which is represented on the boards of governors.

Prior to 1939 several of the Polytechnics had affiliated trade schools; but under the Education Act of 1944 these have become independent secondary technical or modern schools, and more and more the Polytechnics have assumed a characteristic pattern catering primarily for full-time or part-time students of seventeen years or older who wish to follow courses leading to degrees of the University of London or to diplomas or certificates in various technologies. There has been a general tendency for a stratification of technical and higher technological education and, while some subjects are taught in all the Polytechnics, each institution has adopted certain fields as its own.

Thus The Borough Polytechnic, apart from its general courses in science and engineering, has, since its establishment in 1891, often taken the initiative in meeting the special needs of an industry and in more than one case has followed the dictum of the American educationist that a technological institute "must lead industry; it must reflect the future rather than mirror the past". The Polytechnic has provided pioneer courses in such subjects as bakery (1894), paints (1892), oils and fats (1893), plastics (1930), chocolate and sugar confectionery (1947), pulse techniques (1951), pest control (1952) and applied nuclear physics (1952). In 1948 the National College of Heating and Ventilation, Refrigeration and Fan Engineering was established under the directorship of Dr. D. H. Ingall, the principal of the Polytechnic. This, like other similar 'national colleges', receives direct grants from the Ministry of Education. Various departments or sections of the Polytechnic have a *de facto* or *de jure* regional or national status in that they attract students from a wide area.

The science work of the Polytechnic began at an early date, and students gained B.Sc. degrees of the University of London as early as 1903. The Chemistry Department of the Polytechnic was established in 1897 under the direction of F. Mollwo Perkin; he was followed by C. Doree (1909) and H. Lambourne (1924) and then by Dr. E. C. Pickering (1926), who retires this year after seeing his Department re-established in the new extension.

The new building includes four floors, with lecture rooms and laboratories for different branches of chemistry and for botany, zoology and biochemistry. From each of the 'academic' sections of the science department branch off various 'applied' lines of activity, some of which have been identified with the Polytechnic for long periods.

In the field of applied chemistry, facilities (including pilot-plant equipment) are available for plastics; paints, varnishes and pigments; oils, fats, waxes, soaps and detergents; and for dental mechanics. In applied biology special provision is made for microbiology and hygiene, and for entomology and pest control. The food science and technology section includes laboratories for food analysis and for cereal testing—with a collection of instruments for the measurement of the physical properties of cereal products rarely seen outside the research laboratories of a few of the larger firms. Extensive provision is made for instruction in bakery subjects and for chocolate and sugar confectionery.

Since 1945 a number of postgraduate and other specialized courses sponsored by the Regional Council for Higher Technological Education have been arranged at the Polytechnic in such subjects as synthetic detergents—to meet the needs of a rapidly growing industry—and in food biochemistry and human nutrition, the lecturers being drawn from the university medical schools and from research institutes.

Such courses as these, on subjects normally available only to limited groups of full-time university students (and sometimes not available at all in the universities), are an essential part of the work of a modern Polytechnic; they aim at meeting the needs indicated by the members of so many production teams who have visited the United States and have pleaded on their return for an extension of the training facilities for scientific workers and technologists in industry. The Polytechnic has been fortunate in securing the co-operation of university lecturers and other scientific workers in research institutes, in industry or in private consultant practice, who to an increasing extent have shown their willingness to direct these specialized courses.

It is part of the policy of the Ministry of Education and of the London County Council to encourage research in the Polytechnics, and the new extension at The Borough includes research laboratories for organic chemistry and biochemistry; postgraduate students and also members of the teaching staff are working for higher degrees of the University of London or for the fellowship of the Royal Institute of Chemistry.

The Ministry of Education has made arrangements with the Commissioners of Inland Revenue, whereby industry may claim tax relief on grants to Polytechnics. The Borough Polytechnic has benefited from this new approach and acknowledges the assistance received from various sections of industry. These recent gifts follow an earlier pattern and justify the optimism of Sidney Webb (in his introduction to a volume published in 1910 to record the origin and growth of the Polytechnic): "how little

there is of truth in the statement that the grant of public money necessarily dries up the sources of private benevolence".

In the same article, Webb recorded his conviction "of the great advantage that the Borough Polytechnic has derived from its independence in administration, and its freedom to start new experiments", and expressed the prophetic view that "it is one of the special problems in Democracy which make the twentieth century so interesting to discover how we can most successfully fit the voluntary agency in the government framework so as to secure the maximum advantages of both".

The Governing Body of The Borough Polytechnic has provided a field for voluntary endeavour on the part of many distinguished men and women, and in this number must be placed Mr. D. C. Highton, who, on his retirement last month from the chairmanship (following more than twenty-five years service in this capacity), can see in the new extension the results of his endeavours and the beginning of a new phase in the history of The Borough Polytechnic.

FRANCIS AYLWARD

LUMINESCENCE OF INORGANIC PHOSPHORS

A CONFERENCE on luminescence with specific reference to inorganic phosphors was held in the Cavendish Laboratory, Cambridge, during April 7–10, being organized by the Electronics Group of the Institute of Physics. This was the first large-scale conference in Europe on the subject since the Faraday Society conference in Oxford in 1938 and was attended by many visitors from Europe, India, Canada and the United States. Proceedings were arranged to give ample time for discussion by previous circulation of preprints of papers which were read in précis form.

An opening lecture by Dr. S. T. Henderson (Thorn Electrical Industries, Enfield) reviewed the advances in luminescence since 1938 with particular reference to the commercial developments of fluorescent lighting and electroluminescence and to the extensive progress in fundamental research on phosphor constitution and mechanisms of luminescence. This was followed by a demonstration lecture given by Dr. J. W. Strange (Thorn Electrical Industries, Enfield) on some unsolved problems in luminescence, such as sensitization of luminescence, infra-red response of phosphors and the complexities of thermal glow phenomena.

The main proceedings fell into three daily sessions, the first being devoted to phosphors involved in commercial applications. The opening paper, by Mr. C. G. A. Hill (Levy-West Laboratories, Wembley), reviewed developments in cathodoluminescence with special reference to applications such as calcium–magnesium silicates for 'flying-spot' tubes and the zinc–magnesium fluorides with 1/10 sec. exponential decay for radar screens. As indicated by this and a later paper, some phosphor efficiencies for cathode-ray excitation are nearing the maximum possible values.

There followed a series of four papers on phosphates and other phosphors of particular interest for fluorescent lamp application. The first, by Miss M. Doherty and Mr. W. Harrison (Siemens Lamp Research Laboratories, Preston), was concerned with phosphor synthesis, chromaticity and ageing of fluorescent coatings. In the latter case, improvement on 1946 performance due to the use of the halophosphate phosphors was very evident. The second of these papers, by Dr. P. W. Ranby, Mr. D. H. Mash and Dr. S. T. Henderson (Thorn Electrical Industries, Enfield), considered the alkaline earth pyrophosphates in some detail, with special reference to the relations between phosphor characteristics and crystal structure. The third paper, by Mr. A. H. McKeag and Mr. E. G. Steward (General Electric Research Laboratories, Wembley), also stressed the structural aspects of phosphate and of silicate phosphors in relation to their luminescence characteristics. A short paper by Dr. S. Rothschild described some unusual phosphors, notably boron phosphate, alkaline earth vanadates and some arsenatoapatites.

The second half of the session was given up to a number of papers on electroluminescence. The continuous excitation of luminescence by application of an alternating electric field to a phosphor was reported by Prof. G. Destriau (Paris) at the Oxford conference in 1938. He presented a paper in the present proceedings on the brightness wave-forms of electroluminescence. During recent years, electroluminescent phosphor plaques as large-area light sources have been developed commercially. Dr. K. H. Butler and Dr. J. F. Waymouth (Sylvania Electrical Products, Salem, United States) gave a paper mainly concerned with the production and characteristics of phosphors used in these electroluminescent lamps. Another paper, by Prof. A. Luyckx (Louvain) and Mlle. A. J. Stokkink (Charleroi), described brightness/applied voltage characteristics for conventional phosphors. An outstanding paper of this group was that of Dr. W. W. Piper and Dr. F. E. Williams (General Electric Co., Schenectady, United States), providing a theory of electroluminescence in terms of a Schottky exhaustion barrier model for the phosphor-electrode boundaries. Discussion on this paper included a notable contribution of a modified theory by Dr. G. F. Alfrey and Mr. J. B. Taylor (University of Birmingham), which took into account electrons thermally excited from trapping-states. This theory correlated well with experiment, particularly with reference to the complex temperature variation of electroluminescence. Two short papers concluded the session, one on electroluminescence in organic adsorbates by Prof. A. Bernanose (Nancy) and one on electroluminescence in silicon carbide crystals by Dr. G. Szigeti (Budapest). From the papers and discussions it was evident that electroluminescence research is attracting much attention from both industrial and academic laboratories.

The second session focused attention on the physical chemistry of phosphors and attempts to determine their detailed constitution by physical measurements. The opening paper, by Dr. F. A. Kröger (Philips Research Laboratories, Eindhoven), gave an up-to-date review of the physico-chemical approach made by his laboratories and of the theory of activation of sulphides in terms of lattice vacancies and valence compensation. Discussion on this paper included a consideration of the function of 'killer' impurities, of the spatial relations between co-activator ions in the sulphides and of the possibility of applying paramagnetic resonance techniques to determine the state of impurity ions in the matrix crystal lattice. The second paper, by Dr. J. H. Schulman (Naval

Research Laboratories, Washington, D.C.), discussed the deductions to be made concerning the nature of emission centres from such physical measurements as dependence of efficiency, phosphorescence decay and absorption and emission spectra on temperature, characteristics of sensitization and concentration quenching. The paper by Dr. G. R. Fonda (General Electric Co., Schenectady), which followed, considered energy transfer between activators in calcium halophosphate phosphors. A paper by Dr. C. C. Klick (Naval Research Laboratories, Washington, D.C.) brought to the fore the particular case of divalent manganese as a luminescence activator in solids. Both the paper and subsequent discussions showed clearly the divergence of opinions on the relations between spectral characteristics of luminescence and the state of the manganese ion, that is, whether spectral changes are due to association and clustering of impurities or to changes in co-ordination of the impurity with its surroundings. The idea of pairing of impurities was emphasized in more detail for specific cases, such as alkaline earth oxides, uranate and fluoride phosphors, in a theoretical paper by Mr. W. A. Runciman (General Electric Laboratories, Wembley).

The last session of the conference dealt with fundamental mechanisms of luminescence in solids and opened with a paper by Dr. G. F. J. Garlick (University of Birmingham) on absorption, emission and storage processes in sulphide phosphors. There followed a theoretical paper by Dr. I. Broser and Dr. R. Broser-Warminsky (Berlin) on the correlation of luminescence and photoconduction characteristics with energy-states of single-crystal phosphors. These authors also presented new experimental results on thermoluminescence and dark current against temperature variations in single sulphide crystals. These papers and the discussions on them emphasized the difficulty of determining the energy distribution of trapping-states in phosphors by the sole use of thermal glow experiments. Contributions from members of the Eindhoven group indicated some new methods of detecting trapping-states not operative in thermoluminescence. Control and analysis of phosphors for such experiments is essential, and the use of radioactive isotopes of constituent elements for this purpose was described in a contribution by Dr. E. and Mme. B. Grillot (Paris).

The progress made in recent years in the theory of localized activator centres in phosphors, particularly for impurities such as thallous and manganous ions in ionic solids, was described by Dr. F. E. Williams (General Electric Co., Schenectady). An important feature of the paper was the extension of the theoretical methods to covalent crystals such as zinc and cadmium sulphides activated by copper which are usually treated on the basis of the energy-band model. The next paper, by Dr. G. F. J. Garlick (University of Birmingham), attempted to lay a sound foundation for a quantitative theoretical treatment of cathodoluminescence. The final paper, by Dr. C. A. Duboc (Eastman-Kodak Co., Rochester, United States), discussed non-linear relations between fluorescence and excitation density in photoconducting phosphors, a subject of much interest in recent years. Exhaustive analysis was made of the possible energy-level schemes giving rise to non-linearity effects.

Discussions on the papers of this session were lively, probably because experimental investigations do not yet yield results which can distinguish between the various theoretical approaches and models.

The general impression given by the proceedings was that phosphor research is becoming more exact and more closely related to other fields of solid-state physics—for example, to semi- and photo-conduction. There was even mention of a possible role for dislocations in the formation of some types of emission centre. It was further evident that, although powder-form phosphors are still the most important materials for commercial use, precise fundamental investigations demand that the specimens shall be in single-crystal form.

G. F. J. Garlick

ATMOSPHERIC CONTAMINATION IN INDUSTRY AND THE HEALTH OF THE WORKER

On April 6 the British Occupational Hygiene Society held a conference at the London School of Hygiene and Tropical Medicine, which was devoted to the discussion of problems of atmospheric contamination in industry and its effects on the health of workers. The conference was attended by a hundred and fifty members and visitors. Copies of the proceedings will be available from the honorary secretary, Mr. Peter C. G. Isaac, Public Health Engineering Laboratory, King's College, Newcastle upon Tyne.

The first paper, "The Investigation of Atmospheric Contaminants in Factories", was presented by two authors, Dr. M. W. Goldblatt, head of the Industrial Hygiene Laboratories, Imperial Chemical Industries, Ltd., and Dr. J. C. Gage, head of the Biochemical Section of these Laboratories. In dealing with the fundamental aspects, Dr. Goldblatt suggested that the present standards of medical supervision of workers have to be considered as minimal. While it is true that big organizations have safety and medical departments, the workers and managements of the 230,000 small factories that have less than 100 employees have little contact with the medical profession. Although the number of notified cases of industrial poisoning is very small, this gives a false impression, and it is probable that the absorption of toxic materials is widespread in industry. It is possible that, with modern medical diagnosis and treatment, men suffering from mild, chronic poisoning can be kept at work. Dr. Goldblatt said that it is important that where toxic materials may be absorbed by the workpeople, their concentration in the air should be determined. It is also important to keep adequate records so that, over a period of time, it may be possible to correlate the clinical histories and the concentration of toxic materials in the atmosphere. The concept of 'maximum allowable concentration' has come into fairly common use, but Dr. Goldblatt suggested that 'allowable' concentrations always have to be zero. He agreed that in practice it is necessary to accept a 'design' concentration which may be used by the engineer designing the equipment as a criterion for the efficiency of any control system. This design concentration should be such that the health of the exposed workers is not affected over a prolonged period of time. He warned his audience against the wrong use of the published tables of 'maximum allowable concentrations'. In particular, it is mis-

leading to compare materials having different effects. It is also most dangerous to predict the toxicity of the materials by chemical analogy.

In presenting the second section of the paper, Dr. Gage pointed out that, unlike studies of atmospheric pollution in towns, the nature of the hazardous material is usually known within the factory. He stated that the requirements of a method for general use in a factory are that it should be unobtrusive, inexpensive and self-contained; it should give an immediate result and be sufficiently simple to be used by a laboratory assistant or foreman. Also, it has to be adequately accurate and specific. Sampling equipment of this type is particularly suitable for the testing of air purity before men are permitted to enter a tank or enclosed space. Dr. Gage outlined the main types of methods available and gave a demonstration of an indicator tube for carbon monoxide; this is a very simple procedure which he thinks should be extended to other gases. Reference was made to more complex instrumental methods—for example, the mercury vapour detector using ultra-violet light absorption, or the infra-red analyser which could be used for a number of different materials. These instruments are capable of giving a written record of atmospheric concentrations over a long period of time and can be designed to give an automatic warning if safe limits are exceeded, but their use in occupational hygiene is limited.

Dr. B. M. Wright, of the Pneumoconiosis Research Unit, presented a paper entitled "The Measurement of Dust Exposure for the Control of Pneumoconiosis", in which he said that it is essential to study both the incidence and severity of pneumoconiosis and the level of exposure to dust. The former is affected by the duration of the exposure and the concentration and composition of the dust. Once a relationship is established, then the safe limit will depend on what incidence and severity of pneumoconiosis is considered permissible. To make such studies possible, it is essential that general agreement should be reached on the methods of making the measurements, and then these methods will have to be applied on a wide scale.

The only instrument in common use that enables an estimate to be made of the concentration of respirable dust (between 5 and 1 μ in size) is the thermal precipitator. This collects the dust without breaking up aggregates but, owing to its comparatively short sampling period, its use becomes exceedingly laborious when long-term exposures are to be determined. The essential requirements of a suitable sampling instrument are: to enable an estimate to be made of the concentration and composition of airborne dust particles and aggregates in the respirable size-range; to yield a sample which can be assessed reasonably easily and accurately; to be capable of integrating its exposure over at least one working week; and to be cheap, robust, light, portable, self-contained and automatic. Until such an instrument has been produced and used over a period of many years, safe limits of dust exposure cannot be established with any precision. After his lecture, Dr. Wright displayed several new pieces of sampling apparatus, including a double aspirator for the thermal precipitator, an automatic sedimentation cell, and a selective mass-sampler. He said he hoped that the latter two instruments would make it possible to assess the level of exposure more accurately and less laboriously than has been possible hitherto.

Dr. W. G. Marley, head of the Division of Health Physics, Atomic Energy Research Establishment, Harwell, read a paper on "Permissible Levels of Exposure to Ionizing Radiations and Radioactive Materials". At the beginning of his paper he said that, with the introduction of a wide range of isotopes and the ever-increasing use of equipment emitting X-rays and gamma-rays, it has become necessary to re-examine early information on permissible levels of exposure and to extend their applicability. At the 1953 meeting of the International Congress of Radiology, the International Commission on Radiological Protection drew up a list of recommended values for the maximum permissible body burden of a wide range of isotopes, and of the corresponding levels in air and drinking-water. This is soon to be published. Dr. Marley discussed the derivation of some of these recommended values. From prolonged and wide experience of X-rays and gamma-rays, it has been possible to arrive at a basic tolerance of 0·3 r./week in the tissue, which corresponds in certain circumstances to approximately 0·5 r./week measured with back-scatter on the surface of the body. Experience of radium ingestion by radium dial painters has enabled another basic tolerance to be set, namely, 0·1 μgm. radium fixed in the skeleton, and this is thought to be safe over a working lifetime.

By making allowance for the 'relative biological effectiveness' of the different types of radiation or isotopes, it has been possible to determine permissible levels of exposure to a wide range of substances. The 'relative biological effectiveness' is usually determined from animal experiments, but there is also a limited experience arising from accidental exposure of men. Parameters that affect the calculation of permissible levels include the fractional uptake from lungs or gut, the metabolism of the element, the organ of concentration, the biological half-life and the overall relative toxicity. The recommended levels are based on occupational exposures, when only a small fraction of the population are exposed. Dr. Marley stressed that, should an appreciable part of the whole inbreeding population be exposed, then genetic effects would have to be considered. He also discussed the effects of exposure, either by accident or in an emergency, to much more intense radiation for short periods.

R. J. Sherwood

DISTRIBUTION MAPS OF THE BRITISH FLORA

THE British Isles are probably as well known botanically as anywhere on the earth's surface; the long unbroken tradition of field botany as a hobby, traceable from the seventeenth century, has resulted in the accumulation of a mass of information on the occurrence of higher plant species, much of which has been systematized during the past hundred years on the 'vice-county' recording system due to H. C. Watson. This system, which constituted an important advance in the recording of plant distribution at the time of its inception in 1852, has naturally revealed inadequacies since that time, and at a conference in 1950 the Botanical Society of the British Isles reviewed the whole question of aims and methods in the study of distribution of British plants, in the light of the requirements of modern botanical research. At this conference recent methods of mapping in use in other countries were discussed,

and Prof. A. R. Clapham outlined a project for preparing and publishing a set of distribution maps which should be comprehensive, accurate and readily available to botanical workers in Britain and elsewhere. A special committee was set up to inquire into the practicability of such a scheme, and the project, eventually made possible by a grant of £10,000 from the Nuffield Foundation, was launched at the Society's conference held recently in London.

The work is to be centred in Cambridge and is to take five years. Essentially, it consists of the accumulation in a convenient form of data of two main types—namely, individual species records (principally from the main public herbaria and the published literature), and field lists compiled by reliable workers—and the subsequent transference of these data to standard base-maps. Many possibilities of mapping were considered, and the final decision was to indicate by means of a conventional symbol the presence of each species within each 10-km. square of the Ordnance Survey National Grid. Such a map of the British Isles, reproduced at a size about 6 in. by 4 in., would reveal by a pattern of dots the broad features of distribution and its correlation with climate or geological formation; moreover, the basis of any individual dot could be readily found by reference to the records.

There are some two thousand species of vascular plants in the British flora (an approximate figure including apomictic micro-species, but excluding most casuals), and there are more than 3,500 10-km. grid squares. This may mean that a reasonably complete survey would accumulate 2,500,000–3,500,000 individual records, a formidable undertaking for which a mechanically sortable punched-card system is clearly desirable, if not essential. Careful investigation of such systems revealed that not only did they possess great advantages in ease of handling and sorting, but also that it was possible to tabulate mechanically the individual maps from the set of cards referring to a particular species.

A Powers-Samas 40-column card installation has been chosen, by means of which data relevant to a particular record are coded, punched on to a small card and put in a permanent card index. This card index will be used not only for the immediate preparation of the maps, but also to provide the basis of a recording scheme for the Nature Conservancy, which, in addition to giving direct grants to the maps project, is financing this recording and mapping machinery. An incidental advantage in the use of punched cards is that quick and easy production of 'interim maps' during the working of the scheme is thereby made possible; this can be a most important stimulus to further effort, as it can immediately reveal gaps in the existing records.

In addition to the great mass of information stored in literature and herbaria, it is hoped to utilize, particularly for the commoner species, the help of a great many amateur and professional botanists, who are being approached directly through universities, schools, national and local scientific and natural history societies. It is probably true to say that in helping in this scheme the field botanist can make a larger and more valuable contribution to accurate scientific knowledge than ever before.

Information on the scheme in general, and on the type of observations required from field botanists willing to co-operate, can be obtained from B.S.B.I. Distribution Maps Scheme, Botany School, Downing Street, University of Cambridge. S. M. Walters

ROCKEFELLER FOUNDATION GRANTS

THE following grants to institutions and persons in Great Britain have been made by the Rockefeller Foundation, New York, for the first quarter of 1954.

Medical Research Council of Great Britain: an appropriation of 125,000 dollars for fellowships in the medical sciences.

National Institute of Economic and Social Research, Great Britain: an appropriation of 60,000 dollars (to provide up to £20,000) for a study of the economic experience of the United Kingdom during 1945–53.

Royal Institute of International Affairs, London: an appropriation of 31,500 dollars (to provide up to £10,500) for the Institute in support of a study of race relations in Central Africa, under the direction of Mr. Philip Mason.

Royal Institute of International Affairs, London: 3,100 dollars to enable Miss Lois Simpson, press librarian, and Miss Helen G. Liddell, head of the Information Department, to visit the United States and Canada in connexion with their work at the Royal Institute.

University of Liverpool: 1,500 dollars toward travel and/or living expenses of foreign delegates invited to participate in a symposium on the comparative endocrinology of vertebrates to be held at Liverpool in July.

King's College, London: 8,000 dollars toward research in electrophysiology under the direction of Dr. Donald M. MacKay.

University College, London: 1,525 dollars to enable Prof. George C. Allen to renew his acquaintance with economic conditions and scholarly work in Japan and the United States in connexion with bringing up to date his work on the history of Japanese economic development.

University of London: an appropriation of 24,000 dollars for the purchase of an electron microscope to be used in King's College for research in biophysics under the direction of Prof. J. T. Randall.

Prof. F. W. Rogers Brambell, University College of North Wales, Bangor: 1,150 dollars toward travel and living expenses while extending his stay in the United States after taking part in the Cold Spring Harbor symposium on fœtal physiology to be held in June.

Dr. John R. Ellis, sub-dean of the London Hospital Medical College: 2,150 dollars to permit him to visit medical schools in the United States to observe developments in medical education.

Prof. H. J. Eysenck, director of the Psychological Department, Institute of Psychiatry, University of London: 2,700 dollars for travel and expenses to visit centres of research in psychology in the United States and Canada.

Dr. F. P. Glees, lecturer and university demonstrator, Laboratory of Physiology, University of Oxford: 800 dollars to permit him to visit laboratories of neurophysiological research in the United States.

Dr. Hilde T. Himmelweit, London School of Economics and Political Science: 1,150 dollars to enable her to visit major research and training centres of social and clinical psychology in the United States.

Prof. Irene Manton, Department of Botany, University of Leeds: 700 dollars toward travel and

living expenses in connexion with her proposed visit to the United States to study the uses of electron microscopy and to learn special methods of making ultra-thin sections of plant tissues.

Prof. K. R. Popper, London School of Economics and Political Science: £960 (about 2,800 dollars) to extend by six months a period of uninterrupted work on problems of social philosophy and the methodology of the social sciences.

Sir Dennis Robertson, professor of political economy in the University of Cambridge: 2,260 dollars to enable him to visit American universities and research centres.

Miss Margaret B. Swann, lecturer in the Department of Psychological Medicine, University of Glasgow: 2,400 dollars for travel and expenses to visit centres of psychiatric social work in the United States and Canada.

Prof. A. S. T. Thomson, professor of civil and mechanical engineering, Royal Technical College, Glasgow: 1,650 dollars for a visit to sanitary engineering centres in the United States.

Dr. J. Walker, senior lecturer in obstetrics, University of Aberdeen: 400 dollars toward travel and living expenses for visits to laboratories of obstetric medicine research in the United States.

USE OF SYNTHETIC DETERGENTS IN GREAT BRITAIN

THE increasing use of synthetic detergents has caused many people to ask themselves whether we shall not, sooner or later, have to pay for the benefits we get from them. Housewives, who use them for washing-up and other domestic purposes, have ascribed dermatitis and cracked skins to their use; some have doubted whether they do not cause corrosion of domestic utensils and plumbing; industrial users have had similar doubts; and the discharge of industrial and domestic detergents through the sewers has caused serious problems at some sewage works.

The interim report of the Committee on Synthetic Detergents* is therefore of interest to a public that is far wider than those exclusively concerned with the scientific, technical or commercial aspects of detergents. This Committee, appointed in May 1953, is still busily at work; its general interim conclusion, however, is that there is, as yet, no evidence that users of synthetic detergents need be alarmed about the possible ill-effects of these substances, but that detergents may cause, at some sewage works, a definite nuisance and that they may possibly affect the efficiency of sewage treatment and also the condition of rivers and the purity of water supplies.

Dealing with the possibility that washing products based on synthetic detergents may cause dermatitis of the skin, the Committee says that these washing products may, indeed, thus affect the skins of some people, but that washing-products based on soaps and alkalis may also do this. Medical opinion is apparently variable on this question, but, in spite of the widespread use of synthetic detergents throughout Britain, dermatitis is not more frequent either in households or industries than it was when washing-products based on soaps and alkalis were used.

* Ministry of Housing and Local Government. Interim Report of the Committee on Synthetic Detergents. Pp. 8. (London: H.M.S.O., 1954.) 4d. net.

Many housewives use hand-creams after using synthetic detergents, and they should be taught how much of them to use and not to use them in excessive quantities. There is no evidence that traces of these substances left on crockery or other utensils may get into food or drink and have ill effects. Detergents may remove films of grease or soap from household utensils and plumbing systems and may thus expose them to corrosion, but kitchen utensils and pipes have been exposed for years to corrosive substances containing soda and chlorine and no corrosion problem has arisen. The Committee considers that problems of this kind may be left to the makers of kitchen utensils and furniture.

The most serious problem is the effect of detergents on sewage disposal. The detergents continue to produce foam after they have been discharged into the sewers, and the foam may rise, at some sewage works, to a height of several feet, especially at works where the activated sludge system is used. At some sewage works the foam endangers the operatives and, when it drifts off from the works, it becomes offensive to the neighbourhood; because it may contain particles of unpurified sewage, its suppression is a problem of public health. Although this kind of problem may become more acute, it need not, at present, cause alarm. Further research on methods of suppression of the foam is needed, and it is now going on.

Equally important, or perhaps more so, is the possibility that detergents may add to the difficulty being experienced at some sewage works of keeping the effluents up to the required standard. The Committee is giving special attention to this problem. It is also specially concerned with the discharge of effluents containing detergents into rivers, where they may affect water supplies drawn from the rivers, or the life of animals living in the rivers.

The Committee's experimental work is made more difficult by the fact that large-scale experimental work on sewage and on water supplies is restricted by law and by the need to safeguard the purification of water and sewage. An additional difficulty is the differing chemical composition of the various detergents, none of which is a single chemical substance, so that accurate methods of determining small concentrations of them have still to be devised. The Committee does not, for these reasons, expect to be able to finish its work quickly and gives a warning that all generalizations made about the effects of detergents must be treated with great caution.

PLAY IN DOMESTIC CATTLE IN BRITAIN: AN ANALYSIS OF ITS NATURE

THERE is no universally accepted theory of the genesis and goal of play. A. Brownlee, of the Agricultural Research Council Field Station, has recently investigated the manifestations and conditions of occurrence of play in cattle. From his observations he has also carried out both analysis and synthesis in the light of more recent studies of instinctive behaviour and of physiological processes in muscle and the other tissues concerned in play (*Brit. Vet. J.*, **110**, No. 2; 1954).

For the most part the observations were carried out intermittently over a period of years on cattle

of different ages kept under farm conditions indoor and at pasture. Observations were often made continuously for several hours and occasionally for periods of up to twenty-four hours. During the past two years or so, the same individual animals have been observed over an extended period. In addition to these purely observational methods, various experimental procedures were also adopted and the play reactions studied.

Play does not occur uniformly throughout the life of cattle: the following are the conditions under which it has been observed.

(*A*) *General*. Play occurs in the young more than in the adult; in the well-fed healthy animal—poorly fed or sick animals play less, if at all; during good weather conditions—cold, wet weather definitely does inhibit play; in animals kept continuously at pasture without any unusual event occurring play is most likely to occur in later afternoon, and not much, if at all, during midday hours. Play, however, has been observed around midday in cattle at pasture when they saw other cattle being led down an adjoining track.

(*B*) *Particular*. Play will often occur on being released after a long period of confinement, when vigorous play is seen even in adult cattle; during a period soon after feeding—this is often seen in young calves which are being bucket-fed with milk twice daily, and, though not so frequently, in cattle out of doors following the afternoon feeding period. If an observer, after scratching itchy areas of the skin, moves off at a quick walking pace, the animal may follow, playfully kicking up its heels; in animals gaining access to new terrain, when they play immediately, or the instincts of hunger or curiosity may have precedence, in which case play may occur after these instincts have been satisfied.

Brownlee suggests that play in cattle, instead of being, as Groos thought, manifestations of a number of instincts before they are actually required for serious purposes, is one instinct with its own drive, releasers, emotion, consummatory phase and goal.

The goal of play is not to be found in the animal's environment but is tissue-trophic and serves to exercise and thereby maintain tone and adequate vascularization of the play muscles and the other structures involved in play behaviour.

A derived survival value of play is the familiarizing to the animal of certain items in its environment in relation to its play movements: play continues in an environment long after this familiarity has been established.

There is variation in the type of releaser to which individual cattle respond. Sex and age modify the manifestations of play. Rivalry, if it operates at all in play in cattle, is only a minor motive.

It may be that the tendency during play for the behaviour pattern to switch in succession from one type to another can be interpreted as being due to diffusion of stimuli from one centre to another within the central nervous system; that the releaser of play is a gestalt and all the play items in that gestalt become valent together is also possible.

The tendency for a bovine animal to play is influenced by its state of nutrition.

The term 'para-activity' is suggested for play to indicate that, although play resembles in its behaviour the patterns of combat, self-defence, flight and sex mounting, it is, in fact, an entirely distinct phenomenon.

PROTEIN METABOLISM IN LEAVES

In a recent paper, A. C. Chibnall has described some experimental work relating to the protein metabolism in rooted runner-bean leaves (*New Phytol.*, 53, 1, 31; 1954). The observations of many workers have shown that the detachment of a leaf from the parent plant is followed by a rapid breakdown of protein in the lamina, the rate of this process varying from species to species, from leaf to leaf with age for the same species, and also with the carbohydrate level. If detachment of the leaf from the plant leads to some interference with the mechanism of protein synthesis, it seemed possible that some influence of the root-system, for example the upward translocation of a hormone, is responsible for the regulation of the protein-level in leaves. In the investigation now reported it has been shown that the development of roots on the petiole of a detached leaf of runner bean, induced by treatment with indoleacetic acid, arrests the rapid breakdown of protein in the lamina; and that under suitable conditions this isolated leaf can be kept alive and healthy for several weeks. By contrast, leaves with their petioles in water showed the characteristic rapid breakdown of protein, accompanied by the movement of non-protein nitrogen into the petiole, and chloroplast degeneration took place in a few days. The author's summary of the evidence is as follows. "It would appear that on detachment of the leaf from the parent there is initiated almost at once a strong directional shift of nitrogen (and almost certainly of carbohydrate) from the blades towards the distal end of the petiole. This is presumably the normal response of a plant organ to wounding, just as it is known to be in animal organs. If conditions do not favour the healing of the wound and the initiation of root growth, the drain of nitrogen from the blades, accompanied by breakdown of protein, carries on at a high rate and toxic symptoms become apparent within a few days, irrespective of the carbohydrate supply. On the other hand, should conditions, brought about, for example, by treatment with hormones, favour rooting, the rate of outflow of nitrogen to the petiole and also the rate of protein breakdown in the blade is much retarded, and the onset of toxic symptoms may be delayed many days if not weeks. The development of adventitious roots on the petiole of a detached leaf therefore does indeed influence the rate of protein breakdown in the blade.

"This observation provides us with an answer to one of the queries underlying the present investigation. But in itself it provides no direct evidence bearing on the larger question of whether a protein cycle is operative in these detached, and hence by inference in the normal, leaf blades. A cycle implies continuous synthesis as well as breakdown, and it was to obtain evidence that protein synthesis might be going on concomitantly with the observed rapid protein breakdown in the detached leaves that the studies recorded in the following paper were carried out."

In a further study, again using detached runner-bean leaves, A. C. Chibnall and G. H. Wiltshire (*ibid.*, 38) have investigated the protein metabolism, using isotopic nitrogen. Detached leaves of the runner bean were kept for four days in the dark with the petiole immersed in a solution of ammonium

chloride containing isotopic nitrogen. As was expected, considerable protein breakdown occurred in the blades during this period. The residual protein of the blades was extracted, and on analysis was found to contain isotopic nitrogen. The lysine isolated from the hydrolysis products of the residual blade protein was found to contain isotopic nitrogen in both its amino groups. The results are considered to provide evidence for the occurrence of a protein-cycle in leaves, protein synthesis being maintained in spite of conditions which enhance the rate of protein decomposition.

GROWTH-PROMOTING SUBSTANCES IN THE OVARY AND IMMATURE FRUIT OF THE BANANA

By Prof. F. C. STEWARD

Department of Botany, Cornell University, Ithaca, New York

AND

Dr. N. W. SIMMONDS

Banana Research Scheme, Imperial College of Tropical Agriculture, Trinidad

THE observations to be described stem from the idea that vegetatively parthenocarpic development of the edible banana fruit results from the autonomous liberation of growth-promoting substances in the ovary: substances which, in the seeded fruit, would only be liberated after, and as a consequence of, fertilization[1]. The starchy parenchyma that fills the edible banana and surrounds the seeds in seeded kinds originates from the inner layer of the pericarp (the 'lining'); this is the formative layer that responds to growth-promoting substances, though it does not necessarily produce them.

In other work it has been shown that the liquid endosperm of the coconut, that is, the fluid that nourishes an immature embryo, has a great ability to promote cell divisions in mature cells that otherwise would not grow. This has been observed in the case of carrot root phloem, cut far enough from the cambium so that growth by cell division had subsided[2]. In a basal medium (containing a complete range of the organic and inorganic nutrients normally furnished to plant tissue cultures and the vitamins commonly added as supplements), tissue explants of the phloem of carrot root do not grow appreciably. If whole coconut milk is added, they grow rapidly[3], and this effect is not due primarily to indoleacetic acid or related compounds[2]. Some other dicotyledonous tissues respond in a similar way (artichoke tuber[4]), whereas others require other stimulants in addition to coconut milk (for example, 2,4-dichlorophenoxyacetic acid for the potato tuber[5]). By the use of coconut milk, randomly proliferating tissue cultures of a monocotyledon have been obtained for the first time[6]. Nor is coconut milk a unique source of this activity, for it (or its equivalent) has been found to occur, and has been assayed by means of the carrot tissue culture system, in other monocotyledonous sources as well as in a dicotyledon[7]. In all these cases, however, the source of the growth-promoting activity has been the nutrient medium of an immature embryo, and the substance, or substances, responsible accumulate in a situation in which the storage tissue develops precociously with respect to the embryo[7].

The carrot tissue culture system, growing in liquid media under the controlled conditions which have been devised for the purpose[8], therefore constitutes a convenient assay system for suspected growth-promoting materials which can produce an effect equivalent to that of coconut milk, that is, active cell division in cells in which this would otherwise not occur. The purpose of the tests here described was to ascertain whether such activity could be demonstrated in extracts of banana ovaries and thus furnish a clue to the causal factors in the development of these fruits.

Methods. Aqueous and alcoholic extracts of the 'linings' of ovaries (see above)[1] of 'pisang lilan' (an edible form of *Musa acuminata*) were made at 'receptivity' and after four weeks. Materials for test were obtained from the collections of the Banana Research Scheme, Imperial College of Tropical Agriculture, Trinidad. In the receptive ovaries the linings were very thin and a bunch yielded only a sample of 6·4 gm., which was divided between the two types of extract. At four weeks, 5 gm. of material were dissected out and used in each type of extraction. Extracts were made by two different methods: (*a*) by pounding the tissue in cold water, filtering, and then concentrating the solution *in vacuo* at room temperatures; (*b*) by extracting the tissue with hot alcohol and concentrating the extract on a water-bath. These extracts were sealed in tubes with a preservative (chloroform or toluene) and dispatched from Trinidad to Ithaca, New York, for test. (The carrot assays were performed under arrangements made possible by grant *C*-1357 (C_2) from the National Cancer Institute, National Institutes of Health of the United States Public Health Service, and with the assistance of Mrs. Alice Peabody and Mr. E. M. Shantz.) On arrival, the materials were evaporated to dryness, the preservatives were removed, and the residue re-dissolved in warm distilled water. The solution, made to 30 ml. volume, was used in the carrot assay test by adding it in place of coconut milk to: (*a*) basal medium; (*b*) basal medium supplemented by casein hydrolysate (0·05 per cent). The carrot explants used were drawn from a stock which responded appreciably to casein hydrolysate (initial weight 2·6 mgm.; final weight in basal medium 6·1 mgm.; in basal medium plus casein hydrolysate 16·1 mgm.).

Results. Results obtained after fifteen days of growth are summarized in Table 1; they may be interpreted as follows: (*a*) The population of carrot explants used requires coconut milk to grow and, independently of this response, growth may be increased by casein hydrolysate. (*b*) The extract of banana ovaries acts as a source of that part of the growth-promoting effect of coconut milk which requires, but is not replaceable by, casein hydrolysate. (*c*) There is some indication, from comparison of the two times of extraction, that the growth-promoting activity declines with time and with the development of the fruit. Extraction of the growth-promoting factor by alcohol is more efficient than extraction by water.

In short, the response to the banana extract corresponds to that more specific moiety of the coconut

Table 1. Effect of Extracts of Banana Ovaries on Growth of Carrot Root Explants

Time		Receptivity				Four weeks				Coconut Milk	Control
Extraction		Alcohol		Water		Alcohol		Water			
Concentration (per cent) added to medium*		11·0	1·1	11·0	1·1	17·0	1·7	17·0	1·7	10·0	
Basal medium	*A*	12·9	8·0	10·8	11·3	—	—	—	—	119·1	3·5
	B	368	228	308	323	—	—	—	—	3,400	—
	C	10·8	6·7	9·0	9·5	—	—	—	—	—	—
Basal + C.H.†	*A*	49·0	17·5	24·0	26·1	27·8	24·6	10·8	23·3	130·8	14·0
	B	350	125	171	186	200	175	77	166	985	—
	C	37·6	13·4	18·5	20·0	21·4	18·9	8·3	17·9	—	—

A, increment (mgm.) in weight of explants, initially 2·6 mgm., in 15 days; *B*, increment in weight as per cent of increment in control; *C*, increment as per cent of increment in 10 per cent coconut milk.

* For banana extracts, the equivalent in grams fresh weight of original tissue per 100 ml. of medium; for coconut, per cent by volume of whole coconut milk.

† Casein hydrolysate (0·05 per cent).

milk activity which is not due to casein hydrolysate[9], and the alcoholic extract of receptive ovaries was about 38 per cent as effective as whole coconut milk with respect to this activity.

From these observations one could conclude that growth-promoting substances that can stimulate random cell divisions in mature carrot cells occur in significant amounts in the formative layers of the banana fruit. However, the combination of qualities presented in a banana extract, supplemented by casein hydrolysate, is somewhat less comprehensive in its growth-promoting qualities than is that of whole coconut milk similarly fortified. Explants from a different carrot root, tested at the same concentrations as before, showed, in comparison with coconut milk, less decisive growth responses with the banana extract plus casein hydrolysate. Whole coconut milk contains a complex of growth-promoting factors, including the equivalent of something present in casein hydrolysate, and to this complete range of growth substances carrot explants invariably respond. Ovaries and young fruits of banana contain a range of substances similar to, but not identical with, these.

Another set of banana samples was also assayed. Two varieties were used—'pisang lilan' as before, and a wild seeded strain (clone *L*) of *Musa acuminata*. Alcohol extracts prepared as described above were used. Tests were made of the axis with ovules and the parthenocarpic pulp at different stages of development (receptivity and after six weeks) in the edible banana and, in the seeded strain, of the whole contents of the ovary at receptivity, and of the immature seeds and the surrounding pulp, at six weeks.

Both varieties gave evidence of some positive growth-promoting activity in the carrot assay, though generally at a low level in comparison with coconut milk. The results were insufficient to localize precisely the growth-promoting substances within the ovary, but they at least suggest that the axis and/or the ovules may be a site of their production or release.

Conclusions. The general conclusion to be drawn from these experiments is that there occur in the ovaries of both parthenocarpic and seeded bananas growth-promoting substances of the same general nature as occur in coconut milk. It seems a reasonable inference that they are, at least in part, responsible for the growth of the undifferentiated starchy parenchyma that fills the edible banana fruit and surrounds the seeds in seeded kinds. That they may not be solely responsible is suggested by the evidence (ref. 1, and unpublished observations of Simmonds) that auxin-like substances are also involved. (It should be recalled here that both 2,4-dichlorophenoxyacetic acid and coconut milk in synergistic concentrations are necessary to make potato tuber cells grow as a tissue culture[9].) The coconut milk growth factors that affect carrot tissue are clearly not indole compounds[9], and the relative roles of these distinct types of growth-promoting substances in banana fruit development remain a challenging problem.

[March 23.

[1] Simmonds, N. W., *J. Exp. Bot.*, **4**, 87 (1952).
[2] Caplin, S. M., and Steward, F. C., *Science*, **108**, 655 (1948).
[3] Caplin, S. M., and Steward, F. C., *Nature*, **163**, 920 (1949).
[4] Caplin, S. M., and Steward, F. C., *Ann. Bot.*, N.S., **16**, 219 (1953).
[5] Steward, F. C., and Caplin, S. M., *Science*, **113**, 518 (1951).
[6] Morel, G., and Wetmore, R. H., *Amer. J. Bot.*, **38**, 138 (1951).
[7] Steward, F. C., and Caplin, S. M., *Ann. Bot.*, N.S., **16**, 491 (1952).
[8] Steward, F. C., Caplin, S. M., and Millar, F. K., *Ann. Bot.*, N.S., **16**, 57 (1952).
[9] Shantz, E. M., and Steward, F. C., *J. Amer. Chem. Soc.*, **74**, 6133 (1952).

CONTROLLED SPORULATION OF *CERCOSPORA MUSAE* ZIMM. IN PURE CULTURE

By LUCAS CALPOUZOS

Atkins Garden and Research Laboratory (Harvard University), Apartado 414, Cienfuegos, Cuba

CERCOSPORA MUSAE is the imperfect and most conspicuous stage of the pathogen which causes the *Cercospora* leaf-spot disease of bananas, often called the 'sigatoka' disease. The sexual stage of this fungus is *Mycosphaerella musicola*, described by Leach in 1941[1]. Meredith and Butler[2] were the first to observe sporulation of *C. musae* in pure culture. These observations were repeated and enlarged upon by Leach[1], Dantas[3], and Fernandez[4]. However, in all these cases the production of conidia was either not abundant or not consistent enough to offer a reliable supply of spores for experimental purposes. The controlled production of *Cercospora* conidia had not yet been achieved.

Hitherto the critical factor(s) controlling spore production in *C. musae* was generally considered to be associated with the medium used or a combination of medium and other external environmental factors.

The first evidence to the contrary came with my observation that two-week old colonies, originally obtained from a single isolate, all growing in the same culture plates under identical environmental conditions, showed considerable variation in morphology and sporulation. Some colonies were sporulating while their neighbours were not. On other colonies certain island-type sectors were heavily sporulating while other areas of the same colony were covered with sterile growth only. These observations were repeated many times and strongly suggested that genetical factors, hitherto unsuspected, were acting here.

Subsequent studies clearly showed that the critical factor controlling conidial production in pure cultures of *C. musae* is genetic and is not associated with environmental factors as was previously thought. I have been able to develop cultures of *C. musae* that are genetically pure for the ability to produce conidia. The surfaces of these cultures are completely covered with a continuous layer of *Cercospora* conidia from the time the colonies are a few days old and remain in that condition for more than six weeks. These sporulating *Cercospora* cultures can easily be propagated by subculturing only once a month. The spores produced are perfectly normal in their morphology and size and they retain the ability to infect banana varieties susceptible to the 'sigatoka' disease. These sporulating strains have remained stable for more than fifteen consecutive generations.

The quality of sporulation is inherent in these strains and is not dependent on nutritional conditions. In one experiment six media, listed below, were inoculated with spores from the pure sporulating colonies: (1) mycophil agar (Baltimore Biol. Labs.); (2) potato dextrose agar (Difco); (3) corn meal agar (Difco); (4) enriched synthetic medium: mineral salts and glucose with thiamine and biotin added; (5) non-enriched synthetic medium: mineral salts and glucose with no growth factors added; (6) plain agar. The *p*H was adjusted to approximately 6·2 in all these media.

Good growth occurred on mycophil and potato media; a fair amount of growth developed on corn and on enriched synthetic agars, while there was only a trace of growth on non-enriched synthetic medium and plain agar (thiamine being essential for growth). The cultures on the above media were similar in morphology and all were covered with conidia. On the agar plates showing only a trace of growth there were many conidia and conidiophores in proportion to the minute amount of mycelium developed. It seems probable that if any growth can occur in these pure cultures, it will be directed into the formation of sporulating structures and their supporting hyphæ.

The technique of developing pure sporulating cultures from an original wild inoculum has been to remove *C. musae* spores from a leaf spot and make either single-spore or mass-spore isolations on to agar plates. The slow-growing colony that develops almost invariably shows a heterogeneous morphology. The colony consists of a patchwork or an intermingling of sectors differing in colour and texture. Some of these sectors bear spores and such sectors can be recognized after some experience with them. By using a dissecting microscope and a very sharp arrow-pointed needle it is possible to remove some of the sporulating area and subculture it. This process of selective subculturing is repeated generation after generation, always selecting as inoculum only those portions of the colony which show conidial production. Presently, as this process is continued, the successive cultures will show a stronger tendency to produce greater numbers of spores and for a longer period of time. Eventually, either sectors or entire colonies will appear that are pure for the sporulating character.

The behaviour of *C. musae* strongly suggests that we are dealing with a naturally occurring heterocaryon. The spores of this organism are multicellular, and fusions between hyphæ from different cells of a single conidium have been observed. A colony which develops from a single conidium, isolated from a leaf spot, can show as many morphological variations as a colony arising from a group of spores. This happens so consistently that it is difficult to believe that laboratory mutants account for all the variations. Probably not only the colonies in culture but also the spores in the field contain a mixture of genetically different types of nuclei. In contrast, when conidia, either singly or in groups, are subcultured from pure sporulating colonies, they always give rise to homogeneous sporulating growth. It is believed that only one type of nucleus present in the original spore and the subsequent mycelium controls conidial production. The technique of selective subculturing is a method of increasing the concentration of the nuclear type controlling sporulation while progressively eliminating other nuclear types which produce sterile mycelium. Eventually a mycelial system is obtained which is essentially pure for the desired type of nucleus. Any further change which may occur in such a genetically pure culture could be due only to new mutations. My experience seems to indicate that mutations do not occur often in these cultures. When they do occur it is necessary to avoid using such mutant sectors for inoculum in order to propagate the cultures without losing their ability to sporulate.

So far as I am aware, this is the first time that cultures of any species of *Cercospora* have been developed which will produce conidia abundantly and consistently and are stable for this character. Nagel[5] worked on the problem of sporulation in several other *Cercospora* species but was unable to control spore production. One cannot help but wonder whether the results obtained with *C. musae* are also applicable in general to other members of the genus for the control of conidial production.

This study is being carried out as part of the requirements for the doctorate at Harvard University under the direction of Prof. W. H. Weston and is supported by a fellowship established by the United Fruit Co. The work was done primarily at Harvard University's tropical research station in Cuba, and is being continued. A full account will be published elsewhere later.

The presentation of this preliminary communication seems desirable because the control of sporulation in cultures of *C. musae* is of immediate practical importance to plant pathologists, since now for the first time the procedure for securing an ample and dependable supply of spores for laboratory fungicidal screening tests has been developed. [April 16.

[1] Leach, R., *Trop. Agric.*, **18**, 91 (1941).
[2] Meredith, C. H., and Butler, A. F., *J. Jamaica Agric. Soc.*, **43**, 621 (1939).
[3] Dantas, B., Inst. Agron. Norte Bol. Téc. No. 14 (1948).
[4] Fernandez, B. O., *Turrialba*, **3**, 200 (1953).
[5] Nagel, C. M., *Phytopath.*, **24**, 1101 (1934).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Probable Side-effect of Nuclear Reactions in the Biological Action of Fast Protons

Dry dormant seeds of Bonus barley have been irradiated with 160-MeV. protons in the scattered beam of the Uppsala synchrocyclotron. The following biological effects were studied: (*a*) retardation of seedling growth under greenhouse conditions, at 20° C.; (*b*) germination and (*c*) survival at maturity under field conditions; (*d*) sterility (per cent sterile flowers per spike); and (*e*) mutation frequency estimated from the frequency of spikes giving rise to recessive chlorophyll-aberrant types (cf. Gustafsson[1]).

From the specific ionization of the high-energy protons (see Table 1) their efficiency in producing the effects mentioned is expected to be between those of γ- and X-rays. Bombarding animal material with fast deuterons, Tobias *et al.*[2] found an efficiency not very different from that of X-rays. Roughly, this is in accordance with our results. A more detailed analysis indicates, however, that the fast protons are somewhat more efficient than X-rays, and further, that certain qualitative effects are intermediate between those of sparsely ionizing (X- and γ-rays) and densely ionizing radiations (pile neutrons and α-rays).

Some of the differences between the effects of sparsely ionizing and densely ionizing radiations, which have been reviewed[3,4] in order to demonstrate a different mechanism of action of the two types of radiation, are summarized in Table 1. In line 1 the influence of ion density on the mode of dying of plants in the field is illustrated: after treatment with X- and γ-rays, the seeds are killed at once or recover and give mature plants, whereas the lethal effect of neutrons is manifested later in the seedling stage, when mitoses become important for the further growth of the plant. Line 2 shows the highly sterilizing effect of densely ionizing radiations even at doses permitting considerable survival, whereas with sparsely ionizing radiations high sterility is obtained only when a large fraction of the plants is killed. In both these respects the fast-proton effect is intermediate between those of X-rays and neutrons. The same is clearly demonstrated as regards the influence of the water content of the seeds on their sensitivity to radiation, which in the region of 7–20 per cent water increases with decreasing water content[3], an effect totally absent when the irradiation is performed with neutrons.

In the mutation analysis the mutations are referred to different phenotype groups[1], the albina, viridis and xantha types being most common. The relative frequency of the remaining 'rare' types seems to increase with increasing ionization density. With due regard to the statistical uncertainty of the values quoted, it can be stated that in this respect also the proton effect is different from that expected, resembling that of densely ionizing radiations.

An examination of possible explanations led us to conclude that the unexpected effects must be ascribed to secondary ionization caused by short-range particles (mostly α-particles and low-energy protons) formed in inelastic collisions of the high-energy protons with the nuclei of the seed material. The mechanism of such nuclear reactions is not yet known in any detail, but investigations of stars in nuclear emulsion[5,6] seem to indicate that roughly 10 per cent of the incident proton energy is carried away by short-range particles. Using the overall cross-section for star formation in light nuclei (carbon, nitrogen, oxygen) with 130-MeV. protons given by Lees *et al.*[6] (cf. ref. 7), we have estimated the mean energy loss by dense ionization as about 2 per cent of the total energy dissipated. Since the relative biological efficiency of densely ionizing particles for the production of most biological effects in barley is about twenty times the efficiency of X-rays[3,4], the effects of short-range particles from nuclear events will be comparable to those of the directly ionizing protons. (Measurements on the scattered proton beam have shown some contamination by fast neutrons of unknown energy spectrum, originating in inelastic collisions of the protons with the scattering target, the wall of the seed container, etc. These neutrons might be responsible for part of the dense ionization effect observed.) This is in accordance with the biological observations reported here. In wet tissue (for example, germinating seeds or most animal tissue) the relative importance of the effect of dense ionization will decrease, in many cases to about 50 per cent of the value obtained in dry seeds; but it must still be taken into consideration, for example, in radiological uses of high-energy particles.

Table 1. Qualitative Characteristics of the Effects in Barley of Ionizing Radiations

Effect studied	Radiation				
	Cobalt-60 γ-rays	160-MeV. protons	180-kV. X-rays (unfiltered)	Pile neutrons	Radon α-rays
1. Survival at maturity (per cent of seeds sown) at 25 per cent germination	20	9	17	0	
2. Dose giving 50 per cent lethality / Dose giving 50 per cent sterility	0·92	1·67	0·95	1·92	>1
3. Relative frequency (per cent) of 'rare' chlorophyll mutants. (In brackets, total number of mutants investigated)	6·6 (319)	10·3 (639)	8·6 (248)	12·3 (399)	23·1 (65)
4. Effect of water content on radiation sensitivity of seeds	great	small	appreciable	none*	
5. Specific ionization (ion pairs per μ tissue)	8	16	≈100	≈ 1,000–3,000 ≈ 400*	3,700

* Cyclotron-produced neutrons from Be(*dn*)B, 25-MeV. deuterons

A full account of this work will appear in *Hereditas*.

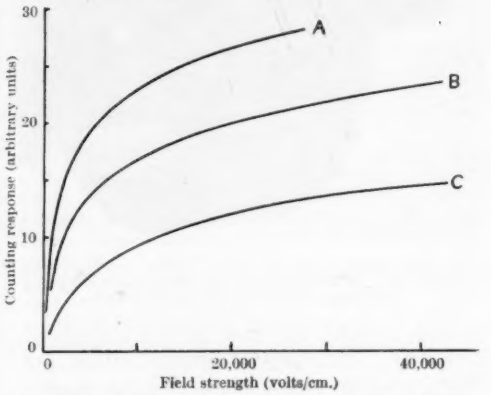
Lars Ehrenberg
Institute of Organic Chemistry and Biochemistry, University, Stockholm.

Göran Andersson
Gustaf Werner Institute for Nuclear Chemistry, University, Uppsala. March 27.

[1] Gustafsson, Å., Lunds Univ. Årsskr., N.F. Avd. 2, **36**, No. 11, 1 (1940).
[2] Tobias, C. A., Anger, H. O., and Lawrence, J. H., *Amer. J. Roentgenol.*, **67**, 1 (1952).
[3] Ehrenberg, L., and Nybom, N., *Acta Agric. Scand.*, **4**, 396 (1954).
[4] Ehrenberg, L., and Saeland, E. (in the press).
[5] Hodgson, P. E., *Phil. Mag.*, **44**, 1113 (1953); **45**, 190 (1954).
[6] Lees, C. F., Morrison, G. C., Muirhead, H., and Rosser, W. G. V., *Phil. Mag.*, **44**, 304 (1953).
[7] Cassels, J. M., and Lawson, J. D., *Proc. Phys. Soc.*, A, **67**, 125 (1954).

Some Effects of Neutron Irradiation of Diamond

FIVE type 2 diamonds, whose ability to transmit ultra-violet radiation and whose response as counters of α-particles had already been examined, were irradiated by neutrons in B.E.P.O. at Harwell. Typical curves showing the variation in counting response (in terms of maximum pulse-height) with radiation dosage are shown in the graph. The general behaviour leaves no doubt that the counting response is progressively reduced with increasing neutron exposure. Similarly, photometric measurements showed that a uniform reduction occurred in the ultra-violet transmission.



(*A*) Initially; (*B*) after ½-hr. irradiation with neutrons; (*C*) after 2-hr. irradiation with neutrons

The obvious interpretation is that additional traps are produced which reduce both the counting efficiency and the ultra-violet transmission. Some recovery in both these properties took place on heating the specimens; but since heating resulted in no improvement in the counting properties of non-irradiated diamonds, it is clear that the intrinsic traps differ in some way from the traps produced by neutron irradiation.

A further feature was that neutron irradiation of the specimens resulted in a decrease in the overall insulation resistance, which was at least partially restored by heating.

These phenomena seem to be connected with those already reported by Griffiths, Owen and Ward[1], and a fuller account of our experiments and their interpretation will be given elsewhere.

A. H. BENNY
F. C. CHAMPION

Wheatstone Laboratory,
King's College, London.
April 1.

[1] Griffiths, J. H. E., Owen, J., and Ward, I. M., *Nature*, **173**, 439 (1954).

Electron Resonance in Ionospheric Waves

IN an earlier communication[1], a brief summary was given of some theoretical work pertaining to the travelling disturbances now regularly observed in the ionosphere[2]. A more detailed discussion has now been prepared for publication, and a new aspect of the investigation has been initiated. As this seems even more promising, and as it may well affect any further work in the reduction of observational data, its more important features are recorded here.

The earlier development was based on the assumption that the disturbances are basically hydrodynamic waves, and that the observed perturbations in the electron density are produced primarily by a resonant electric field generated magneto-hydrodynamically. In the new work, the hydrodynamic wave hypothesis is retained, but the observational selection is now attributed to a direct resonance in the electron oscillations, regardless of any electromagnetic fields which may be generated in the process. It is also assumed that any horizontal propagation must be relatively free from damping if the disturbance is to be observed and recorded by present methods.

The resonant oscillations most simply described are those which occur in an otherwise stationary atmosphere of uniform temperature, and they fall into two distinct classes. In the first, a velocity perturbation of the form $\exp i(\omega t - \mathbf{k}.\mathbf{r})$ is subject to the condition

$$\omega = \gamma^2 g^2 C_e^2 \sin^2 I / 2C^4 K_e, \qquad (1)$$

where γ is the specific heat ratio and C the 'speed of sound' for the atmosphere, K_e is the collisional frequency and C_e the 'speed of sound' for electrons, g is the acceleration due to gravity, and I is the magnetic dip angle. On representing the horizontal component of $\mathbf{k}$ by k_h, its magnetic azimuth by θ, and the vertically downwards component of $\mathbf{k}$ by k_v, it is further found that:

$$k_h^2 C^2 [1 + \cot^2 I \cos^2\theta - (\gamma - 1) g^2/\omega^2 C^2] - k_h \gamma g \cot I \cos\theta + \gamma^2 g^2 / 2C^2 - \omega^2 = 0, \qquad (2)$$

and

$$k_v = (1 - i)\gamma g / 2C^2 - k_h \cot I \cos\theta. \qquad (3)$$

From the latter, it is apparent that hydrodynamic energy is uniformly distributed in height and that a downwards component of propagation is inherent. This component is reduced, however, and may even be reversed, if the poleward component of $\mathbf{k}$ becomes very large. The condition that the roots of (2) must be real will prevent such a reversal if ω is less than about $(\gamma - 1)^{1/2} g \sin |I| / C$, and to a certain extent it also limits the possible range of ω or θ.

Variations from the normal electron density N_0, which alone are relevant in the radio investigations, differ by a factor

$$N_0 [k_v + k_h \cot I \cos\theta + i \operatorname{grad}_v N_0 / N_0] \qquad (4)$$

from the exponential form indicated above. Corrections for vertical variations in N_0 and $\operatorname{grad}_v N_0$ (the downwards component of grad N_0, negative in the regions accessible to direct probing) must therefore be included whenever k_v is related to observation.

It is difficult to extract precise values of ionospheric parameters from the mean observational data published to date, but even approximate estimates reveal a considerable improvement over the earlier results. The large-scale disturbances detected in the F_2-region[3] now lead to increased values for the scale height, 40 km. or more, in closer agreement with other estimates; the earlier difficulty with low γ's appears to have been removed, and no subsidiary considerations need be introduced to explain the observed downwards progression. The collisional frequency can now be estimated if the electrons are taken to be at atmospheric temperature; the value thus obtained for the F_2-layer, several hundred per second, is in good agreement with other measurements and theory[4].

Some of the large-scale disturbances might be associated with the second class of resonant oscillation, for which

$$k_h^2C^2[1 - \cot^2 I \cos^2\theta - (\gamma - 1)g^2/\omega^2C^2] + k_h\gamma g \cot I \cos\theta - \omega^2 = 0, \quad (5)$$

and

$$ik_v \sin I = k_h \cos I \cos\theta = \pm(\omega K_e/2C_e^2)^{1/2}. \quad (6)$$

The estimates of order of magnitude would be much the same, but here there is no vertical propagation except an apparent one introduced by (4), which still applies.

Small-scale disturbances above the F-region maximum, which have been held responsible for certain radio star scintillations, might be related to either set of formulæ given here. Their speed would approach C at the high frequencies recorded, however, and this leads to an estimated scale height of little more than one kilometre in the region concerned; consequently, the suggestion seems rather rash at the present time. Nevertheless, it may be of interest to note that, at these frequencies and at these heights, the second class of oscillation must be propagated very nearly across the geomagnetic field. The commonly observed restriction to such motions[5] is therefore explicable in at least one development of the wave hypothesis, whereas a wind hypothesis for such motions appears untenable unless electric polarization fields compensate almost completely for geomagnetic forces on the blown electrons.

Tidal motions, if horizontal, can be taken directly into account by a reinterpretation of the above formulæ: all must be referred to a co-ordinate system moving with the atmosphere, except perhaps (1) and (6) which properly refer to a system moving with the electrons. The formulæ themselves will have to be modified if there are vertical velocities at all comparable to $|\ \omega/k_v\ |$.

The investigation is continuing, with financial support from the Defence Research Board of Canada, and will be presented in detail in a subsequent communication.

C. O. Hines

Department of Physics,
University College,
London.
Feb. 16.

[1] Hines, C. O., *Nature*, **171**, 980 (1953).
[2] *Nature*, **167**, 626 (1951).
[3] Pierce, J. A., and Mimno, H. R., *Phys. Rev.*, **57**, 95 (1940). Munro, G. H., *Proc. Roy. Soc.*, A, **202**, 208 (1950).
[4] Nicolet, M., *J. Atmos. Terr. Phys.*, **3**, 200 (1953).
[5] Hewish, A., *Proc. Roy. Soc.*, A, **209**, 81 (1951). Maxwell, A., and Little, C. G., *Nature*, **169**, 746 (1952).

A New Gloss Meter incorporating a Method for Accurately Measuring the Polarization of Light

In circumstances where the determination of the gloss of a sheet of paper is the main requirement for indicating surface finish, it has been found very satisfactory to take, as a measure of the glossiness of a surface, its ability to polarize a beam of light reflected at a convenient angle. An instrument has been developed to satisfy the need for an accurate, objective method of measuring the gloss of paper for this purpose. Previous methods[1] utilizing polarization by reflexion have usually involved visual comparisons of fields of light, and have proved subjective and insensitive. The onset of operator fatigue is also rapid.

Photograph showing the arrangement of the rotating cylinder, analyser and photoelectric cell removed from the light-tight housing. Apertures, etc., are not shown

In the new instrument a beam of light, defined by apertures, is reflected from the surface of the test sheet, thus causing partial polarization; the light then passes through a continuous series of polarizing elements, mounted, alternately crossed, around the surface of a transparent, non-polarizing cylinder, rotated by a small motor. After passing through a further rotatable piece of polarizing sheet, used as an analyser, the beam falls on a photoelectric cell situated inside the cylinder.

The rotating cylinder has the sets of the alternate segments aligned so that one set passes all the component of light polarized by reflexion, whereas the other set will not pass this component. The light falling on the analyser is therefore not only polarized alternately in two directions at right angles, but also its intensity is modulated at a frequency depending on the cylinder speed and the number of segments. The fluctuation of intensity of the beam falling on the photocell can be eliminated by adjusting the analyser to a suitable angle. This angle, A, is easily shown to be related to the percentage polarization by the formula:

$$\text{percentage polarization} = 100 \cos 2A.$$

The photoelectric cell output passes into an a.c. amplifier fitted with a suitable output meter, so that the output falls to a minimum at the correct analyser setting, which is therefore easily located.

The conventional arrangement in which the light fields to be equated are viewed simultaneously but separated in space is therefore replaced by one in which the fields coincide in space but alternate in time. The system employs a null method of measurement which is sensibly independent of variations of light intensity, photocell sensitivity, amplifier gain and voltage variations.

Stray light reflected by joints between the polarizing elements causes spurious interference frequencies in the intensity modulation of the transmitted beam. This is overcome by covering the joints with narrow uniform opaque strips, which transform the interference to a regular frequency of uniform amplitude, and this is adequately rejected by the amplifier, which is made highly selective to the desired frequency. To facilitate filtering, the number of equally spaced opaque strips is increased to three times the number of joints, making the major component of interference the sixth harmonic of the desired intensity modulation. The output from the a.c. amplifier can thus be reduced to an almost perfect sine wave which, if displayed on an oscilloscope, can be seen to reduce to practically a straight line at the minimum.

Initial tests have indicated that the instrument is essentially independent of the operator, and individual readings, within the working range, are reproducible to within 0·25°, even without experience.

Since there is a cosine relationship between gloss and the analyser angle, the instrument is not so accurate for very high gloss surfaces, such as glazed ceramics or glossy painted surfaces, when the cosine function changes slowly and sensitivity drops off. Accuracy is still considerably better than with the subjective instrument, however, where exactly the same troubles occur. The highest gloss papers only just extend to this region and do not cause difficulties.

All work so far has been performed on a prototype instrument and full details of the complete instrument, as designed for paper testing, together with its performance, will be published when full trials have been carried out on final models which are under construction. Provisional patents for the instrument have been filed, but it is felt that the method of measuring the percentage of polarization may find useful applications in other fields of work.

L. F. Hopkins
A. P. Highton
Central Research Laboratories,
Bowaters Development and Research, Ltd.,
Northfleet, Kent.
Feb. 15.

[1] Ingersoll, L. R., *J. Opt. Soc. Amer.*, **5** (3), 213 (1921).

The Einstein Relation between Relative Viscosity and Volume Concentration of Suspensions of Spheres

In 1906, Einstein[1] deduced that the relative viscosity η_r of a very dilute suspension of spheres of volume concentration c could be expressed by $\eta_r = 1 + c$. This expression was derived from three equations by elimination, omitting higher-order terms in c. The three equations used by Einstein give directly the expression: $\eta_r = (1 - c)/(1 - 2c)$, which can be expanded to $\eta_r = 1 + c + 2c^2 + 4c^3 \ldots$, simplifying to $\eta_r = 1 + c$ at great dilution.

In 1911, Einstein[2] corrected an error in differentiation that had occurred in his first paper, and so obtained the well-known expression:

$$\eta_r = 1 + 2{\cdot}5c. \qquad (1)$$

The error affects one only of the three equations given by Einstein in his 1906 paper, namely, that expressing the dissipation of heat caused by the presence of the spheres. The corrected expression combined with the other two now gives the final equation:

$$\eta_r = \frac{1 + \frac{1}{2}c}{1 - 2c}. \qquad (2)$$

This expands to $\eta_r = 1 + 2{\cdot}5c + 5c^2 + 10c^3 \ldots$, simplifying to $\eta_r = 1 + 2{\cdot}5c$ at infinite dilution. It appears, therefore, that equation (2) above is the original Einstein relationship between relative viscosity and volume concentration, and a few examples may be given to illustrate its application.

Bingham[3] pointed out that there exists an approximately linear relation between the relative fluidity of suspensions and the volume concentration of solid particles. He used the empirical equation:

$$\frac{1}{\eta_r} = 1 - kc, \qquad (3)$$

where k is a constant.

Equation 2 gives:

$$\frac{1}{\eta_r} = \frac{1 - 2c}{1 + \frac{1}{2}c} = 1 - 2{\cdot}5c + \frac{5c^2}{4} - \frac{5c^3}{8} + \frac{5c^4}{16} \ldots (4)$$

If k in Bingham's equation is given the value of 2·5, the similarity between his equation and equation (4) is immediately apparent, since the higher-order terms of the latter tend to cancel one another out. It may not be surprising, therefore, that other workers[4,5] have found this empirical relation between fluidity and concentration of value.

In particular, attention is directed to the equation recently published by Brinkman[6]: $\eta_r = (1 - c)^{-5/2}$; for volume concentrations up to 10 per cent there is a close correspondence between the values of η_r given by this equation and by equation (2) above.

The following table shows a comparison between the observed values of the relative viscosity of suspensions of spherical killed yeast[7] and the calculated values derived from equation (2):

Volume conc. (per cent)	Observed	Calculated
0·88	1·022	1·022
1·75	1·042	1·045
3·50	1·087	1·094
7·0	1·195	1·204
14·0	1·512	1·486

The results of Eilers[8] are in fair agreement with those calculated from equation (2) up to a volume concentration of 25 per cent, and Vand's results[9] up to 10 per cent concentration.

In connexion with Oliver and Ward's recent communication[5] on this subject, I would comment that the relationship they propose is not new, being first used by Bingham[3] as noted above, and as I have pointed out elsewhere[4]. We have employed Bingham's fluidity equation to suspensions of precipitated calcium carbonate in glycerol; these suspensions are dispersed, and are stable in that they show no settlement on standing for several hours. The value for the constant k was found to be related to the shape and size of the calcium carbonate particles. The wide applicability of equation (3) was re-emphasized with examples by Dr. E. R. S. Winter in a paper given jointly with me, at a discussion on

suspensions and sedimentation in May 1949, and reported in these columns[10].

A. J. Hughes

John and E. Sturge, Ltd.,
1 Wheeleys Road, Birmingham 15.

[1] Einstein, A., *Ann. Physik*, **19**, 289 (1906).
[2] Einstein, A., *Ann. Physik.*, **34**, 591 (1911).
[3] Bingham, E. C., and Durham, T. C., *Amer. Chem. J.*, **46**, 278 (1911). Bingham, E. C., "Fluidity and Plasticity" (McGraw-Hill, 1922).
[4] Hughes, A. J., M.Sc. thesis, Univ. of Wales (1949).
[5] Oliver, D. R., and Ward, S. G., *Nature*, **171**, 397 (1953).
[6] Brinkman, H. C., *J. Chem. Phys.*, **20**, 571 (1952).
[7] Eirich, F., Bunzl, M., and Margaretha, H., *Kolloid Z.*, **74**, 276 (1936).
[8] Eilers, H., *Kolloid Z.*, **97**, 313 (1941).
[9] Vand, V., *J. Phys. Coll. Chem.*, **52**, 277 (1948).
[10] Ward S. G., *Nature*, **164**, 220 (1949).

We are indebted to Mr. Hughes for directing our attention to the fact that the equation given by Bingham for the fluidity of a suspension may be developed to give the relationship

$$\eta_r = 1 + kc + k^2c^2 + k^3c^3 \ldots$$

as in the M.Sc. thesis of Hughes, a copy of which he has kindly allowed us to peruse. In the equation, η_r is the relative viscosity of a suspension having a volumetric concentration c of the solid phase; k is a constant.

In our opinion it is not justifiable to expand equation (2) in Hughes's communication to terms beyond the first power of c and to expect it to apply to higher concentrations than that postulated by Einstein, especially as he deliberately neglected the effects of interparticle collisions. Accordingly, any agreement for concentrations higher than that considered by Einstein, between the expanded version of Einstein's equation and those developed by Vand, Brinkman, Roscoe and others, appears to be fortuitous.

Hughes found that the equation

$$\eta_r = 1 + kc + k^2c^2 + k^3c^3 \ldots$$

is applicable to certain slowly settling suspensions. We have found that it holds only for stable suspensions of spheres, for which the value k depends upon the type of viscometer used but does not differ greatly from 2·5. For unstable (settling) suspensions we have found that a relationship of the form

$$\eta_r = (1 + k_1) + (1 + 2k_1)\, kc + (1 + 3k_1)\, k^2c^2 \ldots$$

appears to hold for solid concentrations between 10 and 30 per cent by volume. The numerical coefficient k_1 depends upon the instability of the suspension. It is hoped that detailed results will be published shortly.

Donald R. Oliver
Stacey G. Ward

University, Edgbaston,
Birmingham 15.

A Study of Manganous Complexes by Paramagnetic Resonance Absorption

The paramagnetic resonance absorption of unstable metal complexes in aqueous solution has been explored and has been applied to the measurement of dissociation constants of such complexes. The method has the obvious limitation, in common with other magnetic methods, that direct measurements are confined to those ions and molecules which are paramagnetic. On the other hand, the method, in common with other spectroscopic methods, has the advantage that it can measure directly and rapidly the concentration of the free metal ion in solution without disturbing any pre-existing equilibrium state.

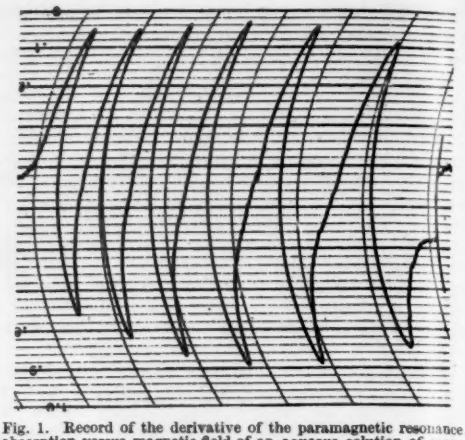


Fig. 1. Record of the derivative of the paramagnetic resonance absorption versus magnetic field of an aqueous solution of manganous chloride (0·005 *M*)

Manganous ion in dilute solid or liquid solution exhibits a hyperfine structure in its absorption when investigated by the paramagnetic resonance absorption method[1]. The existence of this hyperfine structure with its sensitive dependence on the chemical environment of the manganous ion and on type of bond in the molecule, coupled with the widespread biochemical activity of manganous ion, led us to initiate our studies with this ion.

The apparatus used in these studies records the derivative of the absorption curve with respect to magnetic field as a function of the field. Fig. 1 shows a typical record of the spectrum of an aqueous solution of manganous chloride (0·005 *M*), which was scanned from approximately 2,950 to 3,450 gauss in 5 min. with a modulation of 4 gauss and a microwave frequency of 9,000 Mc./s. Similar spectra can be obtained at concentrations ranging from 0·001 *M* to 0·5 *M* with approximately 0·1 ml. solution. The height of the derivative curve from the maximum to the minimum was found to be a linear function of the concentration of manganous ion in the range investigated, namely, 0·001–0·01 *M*, and it was therefore unnecessary to integrate the curves to obtain the concentration.

The phenomenon which made it possible to calculate dissociation constants was the disappearance of the hyperfine spectrum when the manganese formed a complex; the height of the peaks corresponded to the concentration of free manganous ion. When an equimolar concentration of ethylenediamine tetraacetic acid was added to a manganous chloride solution at *p*H 7·5, the peaks disappeared completely. A group of phosphate esters was investigated and it was found, for example, that with a series of increasing concentrations of glucose-6-phosphate, progressively smaller peaks were obtained corresponding to progressively lower concentrations of free manganous ion, as shown in Table 1. From these results, a dissociation constant $4{\cdot}76 \times 10^{-3}$ *M*/litre for a complex of one manganese ion with one divalent glucose-6-phosphate ion can be calculated. The dissociation constant for glucose-1-phosphate was found to be $5{\cdot}18 \pm 0{\cdot}10 \times 10^{-3}$, and those of other mono-

Table 1. Dissociation Constant of the Manganese Glucose-6-Phosphate Complex

Initial concentration, MnCl, 0·005 *M* (tris-(hydroxymethyl)-aminomethane buffer, 0·05 *M*), *p*H = 7·48, *T* = 33° C.

$$K = \frac{(Mn^{2+})\,(G\text{-}6\text{-}OPO_3^{2-})}{(Mn\ G\text{-}6\text{-}OPO_3)}.$$

Initial concentration glucose-6-phosphate (*M*/lit.)	Final concentration Mn^{2+} (*M*/lit.)	$K \times 10^3$ (*M*/lit.)
0·0057	0·00295	4·90
0·0114	0·00187	4·66
0·0171	0·00138	4·95
0·0228	0·00100	4·52
		Average: 4·76 ± 0·17

phosphate compounds were of the same order. The dissociation constants for adenosine diphosphate and triphosphate at *p*H 7·5 were too small to be measured because of the limited sensitivity of the apparatus now available. When 0·001 *M* adenosine diphosphate or triphosphate is added to 0·001 *M* manganous chloride at *p*H 7·5, the hyperfine structure corresponding to the free manganous ion can no longer be observed. This result sets an upper limit on the dissociation constants for these compounds of 2×10^{-5} *M*/litre.

Table 2. Dissociation Constants of Manganese Complexes

Tris-(hydroxymethyl)-aminomethane buffer, 0·05 *M*, *p*H 7·5, *T* = 33° C.

Complexing agent	*K* (*M*/lit.)
Malonic acid	$2{\cdot}20 \pm 0{\cdot}26 \times 10^{-3}$
Glycylglycine	$1{\cdot}45 \pm 0{\cdot}10 \times 10^{-4}$
Histidine	$1{\cdot}76 \pm 0{\cdot}16 \times 10^{-4}$

Several other types of complexes were investigated and the dissociation constants are summarized in Table 2. The values for malonic acid and glycylglycine agree in order of magnitude with those determined by other methods (ref. 2): differences in temperature and concentrations may account for the observed differences. However, the dissociation constant for the complex with the imidazole group of histidine is approximately one hundred times larger than the value obtained by titration (ref. 3). It may be that the assumptions involved in the titration method are not correct for a compound with three ionizing groups; the shift observed in *p*H may be due to the effect on the acid strength of the amino-group in the manganese complex formed between the carboxyl group and the imidazole group, rather than to complex formation itself. It should be pointed out that the temperature was not controlled in these experiments, and the temperature in the cavity was about 33° C.

The disappearance of the hyperfine structure in the complexes studied gives some insight into the type of bond. The explanation of the hyperfine splitting due to manganous ion in solution, that is, of the isotropic component of the hyperfine splitting, as given by Abragam and Pryce[4], is the admixture of the electronic configuration $(3s)^1\ (3p)^6\ (3d)^5\ (4s)^1$ with the usual $(3s)^2\ (3p)^6\ (3d)^5$. If the 4*s* orbital of manganous ion is occupied by electrons donated by other atoms in the complex, as it would be for any type of covalent bond formation, there could be no admixture of 4*s* and therefore no hyperfine structure. Changes in values of static magnetic susceptibility are limited to complexes in which the number of unpaired 3*d* electrons has changed; thus, in manganous compounds a change in static magnetic susceptibility can be observed only when octahedral complexes with d^2sp^3 covalent bonds are formed. On the other hand, all possible types of covalent bond involve the 4*s* orbital and would lead to the disappearance of the hyperfine structure of the paramagnetic resonance absorption in solution. It may be that the presence or absence of the hyperfine structure will prove to be a more discriminating criterion of type of bond, ionic or covalent, than the usual magnetic criterion.

We have failed to detect the paramagnetic resonance spectrum of any complex. There should be a single peak characteristic of the unfilled 3*d* shell of the manganese in the complex even though the hyperfine structure disappears. Inability to detect such a peak is probably due to the lack of sensitivity of the apparatus for very broad peaks; at maximum modulation amplitude, the sensitivity is inversely proportional to the square of the width of the absorption peaks. It is hoped that improvements in instrumentation will permit extension of the method to a kinetic study of complex formation, in particular of metal–enzyme–substrate complexes, and also to the determination of dissociation constants of highly stable complexes.

This investigation was supported in part by a joint programme of the Office of Naval Research and the Atomic Energy Commission; part of the work was done (by M. C.) during the tenure of an established investigatorship of the American Heart Association.

Mildred Cohn

Department of Biological Chemistry,
School of Medicine.

Jonathan Townsend

Department of Physics,
Washington University,
St. Louis, Missouri.

[1] Bleaney, B., and Stevens, J. W. H., "Reports on Progress in Physics", **16**, 108 (1953).

[2] Martell, A. E., and Calvin, M., "Chemistry of the Metal Chelate Compounds", 514 (New York, 1952).

[3] Kroll, H., *J. Amer. Chem. Soc.*, **74**, 2034 (1952).

[4] Abragam, A., and Pryce, M. H. L., *Proc. Roy. Soc.*, A, **205**, 135 (1951).

Anionotropy catalysed by Lewis Acids

Up to the present time, the only catalysts found effective in the anionotropic rearrangements of allylic alcohols, ethers and esters have been 'Brönsted acids', that is, proton donors, which generally function by converting the substrates into oxonium ions[1,2]. It is possible to envisage a second mode of catalysis, involving 'Lewis acids', which would act by co-ordinating with the oxygen atom. Evidence for the existence of this type of catalysis has already been obtained in the case of some allylic halides which have been shown to undergo rearrangement in the presence of substances such as ferric and zinc chlorides[1].

Metallic chlorides are not suitable for investigating the possibility of catalysis by Lewis acids in the anionotropy of allylic alcohols or their derivatives, because of the difficulty of ensuring the absence, and preventing the formation, of hydrogen chloride. We have, however, realized the anionotropy of 1-phenylallyl alcohol (I) to cinnamyl alcohol (II) under remarkably mild conditions by employing boron trifluoride, known to be a powerful Lewis acid. Because of the ready polymerization of both 1-phenylallyl

$$PhCH(OH).CH{=}CH_2 \qquad PhCH{=}CH.CH_2OH$$
$$\text{(I)} \qquad\qquad \text{(II)}$$

alcohol and cinnamyl alcohol under the influence of boron trifluoride, the conditions of reactions require very careful choice, but by operating in dilute solution in dry dioxan at room temperature and following the isomerization by the change in ultra-violet absorption, the desired product can be isolated. In a preparative experiment, a solution 0·15 *M* with respect to both 1-phenylallyl alcohol and boron trifluoride was kept for 4 hr. at 25° and then added to aqueous sodium acetate. Isolation of the products with ether and fractionation gave unchanged 1-phenylallyl alcohol (10 per cent), cinnamyl alcohol (45 per cent, identified by its light absorption and by oxidation to cinnamaldehyde and conversion to the 2 : 4-dinitrophenylhydrazone) and higher-boiling products.

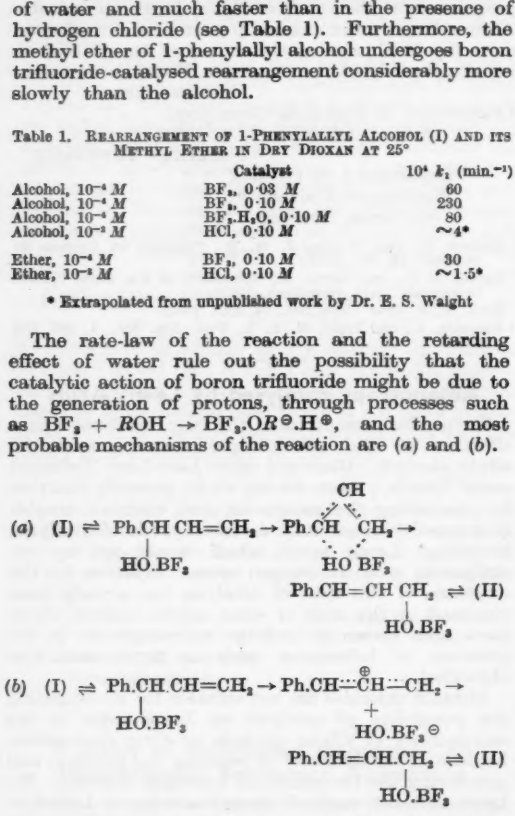
Under the above conditions, the apparent rate of isomerization, as determined spectrometrically[3], rapidly decreases as the reaction proceeds, owing to competing polymerization and other polymolecular side-reactions. Good first-order rate constants are, however, obtained in very dilute solution (10^{-4} *M*) of the alcohol, when polymerization is almost entirely absent. The rate-constants are then proportional to the concentration of boron trifluoride and the rearrangement is strongly retarded by the addition of water and much faster than in the presence of hydrogen chloride (see Table 1). Furthermore, the methyl ether of 1-phenylallyl alcohol undergoes boron trifluoride-catalysed rearrangement considerably more slowly than the alcohol.

Table 1. Rearrangement of 1-Phenylallyl Alcohol (I) and its Methyl Ether in Dry Dioxan at 25°

	Catalyst	$10^4\ k_1$ (min.$^{-1}$)
Alcohol, 10^{-4} *M*	BF_3, 0·03 *M*	60
Alcohol, 10^{-4} *M*	BF_3, 0·10 *M*	230
Alcohol, 10^{-4} *M*	$BF_3.H_2O$, 0·10 *M*	80
Alcohol, 10^{-3} *M*	HCl, 0·10 *M*	~4*
Ether, 10^{-4} *M*	BF_3, 0·10 *M*	30
Ether, 10^{-3} *M*	HCl, 0·10 *M*	~1·5*

* Extrapolated from unpublished work by Dr. E. S. Waight

The rate-law of the reaction and the retarding effect of water rule out the possibility that the catalytic action of boron trifluoride might be due to the generation of protons, through processes such as $BF_3 + ROH \rightarrow BF_3.OR^{\ominus}.H^{\oplus}$, and the most probable mechanisms of the reaction are (*a*) and (*b*).



Mechanism (*a*) is intramolecular and involves the equivalent of an internal hydration–dehydration reaction of an ethylenic bond; it represents the counterpart to the intramolecular rearrangement[1,2] of allylic esters. Mechanism (*b*) is intermolecular and involves the ionic dissociation of the C—O bond to give a kinetically free, mesomeric carbonium-ion and the $BF_3.OH^{\ominus}$ anion. This path is of the same type as that postulated by Burton and Ingold[4] for anionotropic rearrangements generally, though not confirmed by recent investigations[1,2]. No decision between mechanisms (*a*) and (*b*) is yet possible, but the powerful and well-established ionizing influence[5] of boron trifluoride in its co-ordination complexes renders the operation of a mechanism of type (*b*) more likely in the present case than in any similar system previously studied. The greater ease of rearrangement of the alcohol (I) than of the methyl ether is understandable, since it has been shown[5] that the ionic dissociation of boron trifluoride – alcohol complexes is considerably greater than that of boron trifluoride – ether complexes. The retarding effect of water is to be ascribed to its high basicity[6], which will result in competition for boron trifluoride to form $BF_3.OH_2$. Under such conditions the reaction undoubtedly proceeds predominantly by the more usual agency of proton-catalysis, due to the ionization $BF_3.OH^{\ominus}H^{\oplus}$. The data in Table 1 indicate that although $BF_3.OH_2$ is a much stronger proton donor than hydrogen chloride, it is still a far less effective catalyst than boron trifluoride itself.

Grateful acknowledgment is made to the Commonwealth Scientific and Industrial Research Organization for the award of an overseas studentship to one of us (P. H. G.).

E. A. Braude
P. H. Gore

Department of Organic Chemistry,
Imperial College of Science and Technology,
South Kensington,
London, S.W.7.
Feb. 4.

[1] Braude, *Quart. Rev.*, **4**, 404 (1950).
[2] Braude, Turner and Waight, *Nature* [**173**, 863 (1954)].
[3] Braude, Jones and Stern, *J. Chem. Soc.*, 396 (1946).
[4] Burton and Ingold, *J. Chem. Soc.*, 904 (1928).
[5] cf. Greenwood, Martin and Emeléus, *J. Chem. Soc.*, 3030 (1950). Greenwood and Martin, *ibid.*, 757, 1427 (1953); *Quart. Rev.*, **8**, 1 (1954).
[6] Braude and Stern, *J. Chem. Soc.*, 1976 (1948). Hine and Hine, *J. Amer. Chem. Soc.*, **74**, 5266 (1952).

Threonine and the Odour of Protein Hydrolysates

It has been noticed repeatedly in this laboratory that many crystalline proteins such as chymotrypsin, serum albumin, etc., when hydrolysed in sealed tubes with 6 *N* hydrochloric acid at 120° C., gave a pleasant curry-like, spicy odour. A similar treatment of all the amino-acids found in proteins as well as β-alanine, α-amino-*n*-butyric acid, citrulline, ornithine and homocystine, showed that only threonine, allothreonine and the derivative N-2.4.dinitrophenylthreonine gave this odour. It was not detected in digests of threonine prepared at 110° C. in sodium hydroxide (0·005–5 *N*), 0·38 *N* barium hydroxide, 18 per cent ammonium hydroxide, sulphuric acid (2–6 *N*), or nitric acid (0·25–2 *N*), but appeared weakly in 8 *N* acetic acid, 45 per cent formic acid and 45 per cent orthophosphoric acid digests.

Hydrochloric acid was by far the best medium. Thus, with 0·025 *M* (3 mgm./ml.) threonine in 5·5 *N* hydrochloric acid, 10 μgm. of threonine could be detected by odour after 16 hr. digestion at 110° C. and 6 μgm. after 16 hr. digestion at 120° C. All the digests were prepared in sealed tubes, and even with

hydrochloric acid no odour could be detected when the digests were prepared under reflux.

The odoriferous compound was thus fairly volatile, and it could be extracted into ether from the digests. Evaporation gave a pale brown syrup in which no nitrogen could be detected, and which gave a spectrum in water with a single strong peak at 2300 A.

Paper chromatograms of threonine digested at 110° or 120° C. showed much unchanged threonine and the presence of traces of glycine and α-amino-*n*-butyric acid (as already shown by Heyns and Walter[1]). Digestion at 140° C. resulted in much greater destruction, and some alanine appeared. Some trouble was experienced in identifying α-amino-*n*-butyric acid on chromatograms, since with an isatin spray, specific for proline[2], this compound gave a dull blue colour. This was found to be due to the presence of excess hydrochloric acid, since authentic α-amino-*n*-butyric acid, when applied to the paper in 6 *N* hydrochloric acid, also gave a blue colour. The odoriferous compound was found to run at $R_F \sim 0{\cdot}90$ in phenol saturated with water and in butanol–acetic acid–water (5 : 1 : 4 by vol.).

In the amino-acid analysis of hydrochloric acid hydrolysates of proteins, a correction of 5–10 per cent is generally added to the values for serine and threonine[3]. Measurements made here on threonine digests showed a loss of 7–9 per cent of α-amino-α-carboxylic acid (van Slyke–ninhydrin–carbon dioxide method) in 15 hr. digestion at 110° C. in 6 *N* hydrochloric acid, whereas ammonia determinations showed that 3 per cent of the total nitrogen appeared as ammonia in this time. When 11 *N* hydrochloric acid was used, 10 per cent of the total nitrogen appeared as ammonia, and at 140° C. the corresponding ammonia values in 6 and 11 *N* hydrochloric acid were 64 and 73 per cent. Gas, which was identified as carbon dioxide, was produced during the digestions, especially at 140° C.

It is readily possible, therefore, to detect threonine in protein and peptide hydrolysates by a characteristic odour, and while the destruction of the threonine produces small amounts of glycine[1] and α-amino-*n*-butyric acid[1], ammonia, and at higher temperatures alanine and carbon dioxide, the nature of the odoriferous substance is unknown.

I wish to thank Mr. D. A. Maguire for technical assistance.

D. M. P. Phillips

Department of Biochemistry,
Australian National University,
Canberra, A.C.T.
Feb. 26.

[1] Heyns, K., and Walter, W., *Naturwiss.*, **22**, 507 (1952).
[2] Acher, R., Fromageot, C., and Jutisz, M., *Biochim. et Biophys. Acta*, **5**, 81 (1950).
[3] Rees, M. W., *Biochem. J.*, **40**, 632 (1946).

Volatile Acids of Ox Perinephric Fat

Investigations on the fatty-acid composition of ox fat have revealed the presence of a consecutive series of volatile fatty acids from C_2 to C_{10}. Prior to this communication, there appears to be no record of fatty acids with molecular weight lower than that of C_{10}[1] occurring in animal depot fats, with the exception of *iso*valeric acid in porpoises and dolphins[2]. The presence in milk fats of C_4–C_{10} volatile fatty acids with an even number of carbon atoms has long been known and this knowledge has been supplemented by the identification in 1951 of acetic acid in goat milk fat. In recent times, however, volatile fatty acids have also been reported as occurring in the perienteric fluid of *Ascaris lumbricoides* from the pig, in rumen contents of sheep, in grass–water slurries, in the fatty substances present in human hair, in the skin secretions (hair grease) of a number of animals, and in the liver lipids of rabbits and rats.

A sample of beef suet (*J*/21) from the fat surrounding the kidneys was steam-rendered, and the glycerides after neutralization were hydrogenated using a nickel catalyst. The hydrogenated glycerides were saponified with potassium hydroxide, the soaps converted to fatty acids with 40 per cent sulphuric acid, and the fatty acids steam-distilled. The steam distillate was neutralized with potassium hydroxide, taken to dryness on the water-bath, and the soaps obtained were dissolved in water and made up to a 2 *N* solution.

Using the gas–liquid partition chromatogram of James and Martin[3], and the procedure suggested by them for the determination of fatty acids isolated as their potassium soaps, a complete analysis of the volatile fatty acids from C_2 to C_{10} was carried out. The fatty acids were separated by passage through a column of 'Celite 545' and 'D.C. 550'/stearic acid at 137° C. The results are shown in the table.

Acids found	Retention volumes of fatty acids relative to that of *n*-butyric acid		
	X	*Y*	*Z*
Acetic	0·26	0·26	0·26
Propionic	0·54	0·54	0·54
n-Butyric	1·00	1·00	1·00
n-Valeric	1·89	1·87	1·91
n-Caproic	3·58	3·43	3·58
n-Heptylic	6·59	6·59	6·55
n-Octanoic	12·2	12·2	12·0
n-Nonanoic	21·6	21·6	22·0
n-Decanoic	39·0	39·0	40·5

X, Values for a synthetic mixture of C_2 to C_{10} acids; *Y*, values for acids isolated from beef suet; *Z*, values for a synthetic mixture of C_2 to C_{10} acids as reported by James and Martin (ref. 3).

Apart from the nine acids reported above, an unidentified acid was found with a retention volume relative to that of *n*-butyric acid of 27·6, and this value suggests that it may be an isomer of decanoic acid.

It is of interest to note that odd-numbered fatty acids are among those identified in the present investigation. As both odd- and even-numbered fatty acids from C_2 to C_{10} have been found, it seems possible that, in addition to the higher even-numbered fatty acids known to occur in beef tallow[3], there may also be present higher fatty acids of the odd-numbered series[4].

A detailed account of this work will be published elsewhere.

R. P. Hansen
A. G. McInnes

Fats Research Laboratory
(Department of Scientific and Industrial Research),
Sydney Street West,
Wellington, C.1, New Zealand.
Feb. 18.

[1] Hansen, R. P., and Cooke, N. J., *Biochem. J.*, **54**, 14 (1953).
[2] Lovern, J. A., *Biochem. J.*, **28**, 394 (1934).
[3] James, A. T., and Martin, A. J. P., *Biochem. J.*, **50**, 679 (1952).
[4] Hansen, R. P., Shorland, F. B., and Cooke, N. J., *Nature* (in the press).

Biochemical and Osmotic Properties of Skeletal Muscle Mitochondria

In earlier investigations[1] we found that pigeon breast-muscle mitochondria isolated in 0·25 *M* sucrose possessed many of the properties exhibited by liver mitochondria, but lacked those features which are usually associated with fresh preparations of the latter. Such features include the so-called latent adenosinetriphosphatase (ATPase) activity[2], and high P : O ratios when oxidizing α-ketoglutarate. The incorporation of 0·001 *M* ethylenediaminetetraacetate in the 0·25 *M* sucrose, first suggested to us by Dr. A. L. Lehninger[3], and also used with beneficial effects by Slater and Cleland[4] for the preparation of heart-muscle mitochondria, brought about considerable improvement in our preparations from pigeon breast muscle. When fresh, these mitochondria possessed latent ATPase activity and with α-ketoglutarate P : O ratios greater than 2 were obtained, but on storing at 0°, swelling could be observed and the mitochondrial ATPase activity increased progressively until finally after 3 hours it was no longer activated by 2 : 4 dinitrophenol (DNP).

Following the pioneer studies of Claude[5], the swelling and morphological changes of mitochondria suspended in various media have been studied by a number of workers[6–10]. In our attempts to minimize the changes in morphology and biochemical properties occurring during the preparation of mitochondria from pigeon breast muscle, isolation was carried in a medium containing 0·1 *M* KCl, 0·05 *M* *tris*hydroxymethylaminomethanehydrochloride buffer, *p*H 7·4, 0·001 *M* sodium ATP, 0·005 *M* $MgSO_4$ and 0·001 *M* ethylenediaminetetraacetate (*tris*-KCl medium). Coarsely cut-up pigeon breast muscle was homogenized at 0° C. in the Potter–Elvehjem all-glass homogenizer with ten volumes of the *tris*-KCl medium. Myofibrils, nuclei and unbroken cells were sedimented by centrifugation at 600*g* for 5 min., and the mitochondria then separated by centrifugation of the supernatant at 8,000*g* for 10 min. The mitochondria were washed twice by resuspension and resedimentation and finally resuspended in the *tris*-KCl medium.

The ATPase activity of freshly prepared liver mitochondria is very low but greatly increased by ageing and by low concentrations of DNP. Accordingly, the extent of activation of the Mg^{++} ATPase by DNP (latency effect) was taken as an index of the morphological integrity of pigeon breast mitochondria. Table 1 shows the extent of activation

Table 1. Latency of Mg^{++} Activated ATPase of Pigeon Breast-Muscle Mitochondria after Standing in *tris*-KCl Medium from which Various Components have been Omitted

Components omitted from *tris*-KCl medium*	μgm. inorganic phosphate liberated†		Activation (times)
	DNP absent	5×10^{-4} *M* DNP present	
None	11·4	49·5	4·35
ATP	26·0	60·0	2·3
Mg^{++}	22·6	59·0	2·6
Ethylenediaminetetraacetic acid	15·6	47·5	3·0
Mg^{++}, ATP and ethylenediaminetetraacetate	37·5	63·5	1·7

* Mitochondria were washed once with the deficient medium, and resuspended in it for 50 min. at 0° C.

† Phosphate liberated during 5 min. incubations at 20° C. with 0·005 *M* $MgSO_4$ and 0·05 *M* *tris*(hydroxymethyl)aminomethane buffer, *p*H 7·4.

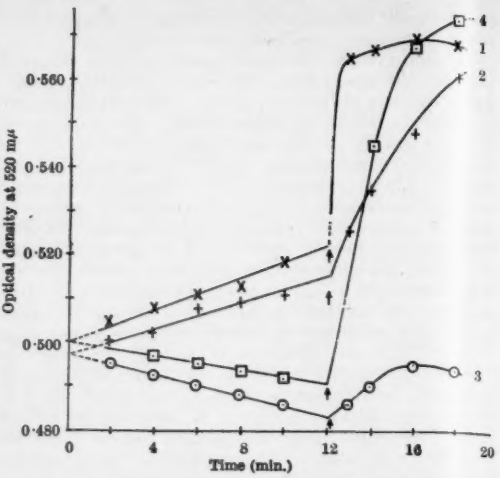


Fig. 1. The effect of ATP, ADP and creatine phosphate on the optical density of a pigeon breast mitochondrial suspension. In all cells 0·1 ml. of mitochondrial suspension was added at zero time to 2·9 ml. of a solution containing 0·1 *M* KCl, 0·05 *M* *tris*hydroxymethylaminomethane buffer, *p*H 7·4, and 0·005 *M* $MgSO_4$. Temperature, 18° C. At zero time the following additions were also made. Curve 1, 0·1 ml. creatinephosphokinase and 0·1 ml. 0·050 *M* ADP; curve 2, 0·1 ml. 0·050 *M* ADP; curve 3, 0·1 ml. creatinephosphokinase. After 12 min. (↑) 0·1 ml. 0·1 *M* creatine phosphate was added in the experiments illustrated by curves 1, 2 and 3. Curve 4, no additions at zero time but 0·1 ml. 0·050 *M* ATP at 12 min. (↑)

which was obtained with DNP when aliquots of a mitochondrial preparation made in the *tris*-KCl medium were suspended and left at 0° for 50 min. in media lacking one or more of the components. It is clear that the latency effect and presumably morphological integrity were best maintained in a medium containing all the components. After 6–8 hr. at 0° in the *tris*-KCl medium the ATPase of the mitochondria was still activated 2–3 times by 10^{-4} *M* DNP or repeated freezing and thawing, and no aggregation of the particles took place. On prolonged storage at 0° the ATPase slowly rose until it approached the value obtained with fresh preparation in the presence of 10^{-4} *M* DNP. Using α-ketoglutarate as substrate, *tris*-KCl prepared mitochondria consistently produced P : O ratios greater than 2 with hexokinase and glucose as the acceptor system in the absence of fluoride and malonate; with adenylic acid, which was not phosphorylated by sucrose-prepared mitochondria, ratios between 1 and 2 were obtained. The rate of phosphate esterification remained constant for at least 40 min. at 20°.

On exposure to hypotonic solutions of potassium chloride, mitochondria freshly prepared in *tris*-KCl were seen under the microscope to increase considerably in size. This swelling was shown to be due to the uptake of water by the mitochondria by direct experiments in which the mitochondrial pellet was sedimented and its water content determined by weighing before and after drying. These volume changes were conveniently studied by following the optical density of mitochondrial suspensions at 520 mμ with the Beckman spectrophotometer, as described by Cleland[11] in studies with heart sarcosomes. Control experiments in which direct determinations of water content were carried out confirmed that a fall in the optical density of the suspensions

corresponded to an uptake of water by the mitochondria.

This swelling in hypotonic solutions could be reversed by the addition of low concentrations of ATP (maximum rate with 0·004 *M* ATP), as is illustrated in Fig. 1. The marked increase in the optical density indicates a reversal of swelling, and simultaneous estimations showed that in such experiments the water content of the sedimented mitochondrial pellet had fallen from 90 to 80 per cent. Increasing the potassium chloride concentration also caused some reversal of swelling in hypotonic conditions, but in this respect potassium chloride was much less efficient than ATP in solutions showing an identical depression of freezing point. The ATP effect appeared to be specific for the following reasons.

(1) Adenosine diphosphate (ADP) in concentrations similar to those of ATP which gave a marked reversal of swelling produced only a slow reversal (Fig. 1), as could be expected by its conversion into ATP by the action of the small amounts of myokinase in the mitochondrial preparation.

(2) In the presence of ADP and creatine phosphate slow reversal was obtained, but as Fig. 1 shows the effect was much increased by the addition of an active creatine phosphokinase preparation.

Inosine triphosphate reversed the swelling at concentrations similar to those at which ATP was effective.

The inhibition of the swelling of liver mitochondria, but not its reversal, has recently been independently reported by Raaflaub[12] using ATP, and by Macfarlane and Spencer[6], who achieved inhibition by active metabolism in the presence of adenylic acid.

Preliminary studies indicate that there is a correlation between the effects of DNP on the activation of the mitochondrial ATPase and its effect on the reversal of swelling induced by ATP. For example, 1×10^{-4} *M* DNP fully activates the ATPase and completely inhibits the reversal of swelling induced by 0·0016 *M* ATP. At lower DNP concentrations the activation of the mitochondrial ATPase and the inhibition of the ATP-induced reversal of swelling are proportionally lower.

These results support the view that ATP may have a special role in maintaining the water balance of the mitochondrion.

It is a pleasure to acknowledge the continued support of the Medical Research Council in the form of a research training grant (to J. B. C.) and a research expenses allowance (to S. V. P.).

J. B. Chappell
S. V. Perry

Department of Biochemistry,
Cambridge.
Jan. 20.

[1] Chappell, J. B., and Perry, S. V., *Biochem. J.*, **55**, 586 (1953).
[2] Kielley, W. W., and Kielley, R. K., *J. Biol. Chem.*, **191**, 485 (1951).
[3] Lehninger, A. L. (personal communication, 1952).
[4] Slater, E. C., and Cleland, K. W., *Nature*, **170**, 118 (1952).
[5] Claude, A., *J. Exp. Med.*, **84**, 61 (1946).
[6] Macfarlane, M. G., and Spencer, A. G., *Biochem. J.*, **54**, 569 (1953).
[7] Dianzani, M. U., *Biochim. Biophys. Acta*, **11**, 353 (1953).
[8] Krebs, H. A., Davies, R. E., and Bartley, W., Royal Society Discussion, London (March 1953).
[9] Harman, J. W., and Feigelson, M., *Exp. Cell. Res.*, **3**, 47 (1952).
[10] Harman, J. W., and Feigelson, M., *Exp. Cell. Res.*, **3**, 509 (1952).
[11] Cleland, K. W., *Nature*, **170**, 497 (1952).
[12] Raaflaub, J., *Helv. Physiol. et Pharmacol. Acta*, **11**, 142, 157 (1953); from *Chem. Abstracts*, **47**, 11271 (1953).

Cytological Fixation of Mitochondria by Acids

Certain acids have been found surprisingly effective for the cytological fixation of mitochondria in various tissues from mice. In some cases, 0·1 *N* hydrochloric acid has proved almost as satisfactory as Altmann's or Helly's fluid (see Fig. 1). Usually, small pieces of tissue are fixed for 18–20 hr. in the acid, washed for two or more hours in water, dehydrated, cleared and embedded in paraffin. The washing does not appear to be essential. Tissues may be dehydrated directly from the acid, starting with 50 per cent ethanol. Sections cut at 3 μ are stained by either Hirschler's hæmatoxylin or Metzner's acid fuchsin technique. With the latter, differentiation is so rapid that it is preferable to use a reagent containing half the usual amount of picric acid. With the hæmatoxylin method, staining is not always uniform. After hydrochloric acid fixation, the mitochondria may be demonstrated in the cells of the liver, intestinal epithelium, renal tubules and pancreatic acini. Other tissues have not yet been studied. The best results have been obtained with liver, the least satisfactory with pancreas. Nitric or sulphuric acid may be used in place of hydrochloric, but the fixation is not quite so good. Chromic, phosphoric, formic, acetic, oxalic and citric acids, potassium dihydrogen phosphate and potassium hydrogen phthalate are unsatisfactory. After acid fixation, there appears to be no advantage in post-chroming the above tissues except, possibly, the pancreas. In the case of hydrochloric acid at least, the results are not improved by making the solution isotonic.

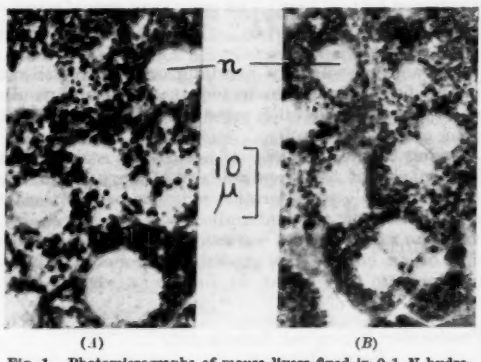


Fig. 1. Photomicrographs of mouse livers fixed in 0·1 *N* hydrochloric acid (*A*) and in Altmann's fluid (*B*). The mitochondria have been stained with acid fuchsin by Metzner's method (n, nuclei)

It is not suggested that hydrochloric acid will replace the familiar mitochondrial fixatives; but it is thought that the resistance of the mitochondria in some cells to certain acids should be made known. These observations also further illustrate the importance of the anion in the fixation of mitochondria, as noted by Zirkle[1].

W. G. Bruce Casselman*
Barbara M. Jordan

Cytological Laboratory,
Department of Zoology and
Comparative Anatomy,
University Museum, Oxford. April 1.

* Merck Postdoctoral Research Fellow in the Natural Sciences of the National Research Council of Canada. Permanent address: Banting and Best Department of Medical Research, University of Toronto, Toronto, Canada.

[1] Zirkle, C., *Protoplasma*, **5**, 511 (1928).

Influence of Mammalian Growth Hormone on Rate of Growth of Fish

The influence of purified mammalian growth hormone on laboratory animals is well known. Pickford and Thompson[1] have shown that it can influence the growth-rate of the marine teleost *Fundulus heteroditus*. At the suggestion of Prof. F. G. Young, the influence of the hormone on hatchery-reared brown trout (*Salmo trutta*) has been investigated.

Batches of ten four-year old fish were used for the work. The experimental fish were injected, intraperitoneally, twice a week with hormone solution, each fish receiving 100 μgm. hormone/10-gm. fish/week. A control batch of fish kept with the experimental fish were similarly injected with 0·6 per cent saline. A third batch of fish kept in a separate pond were unhandled throughout the experiment. All the fish were fed to capacity with a mixture of liver and 'Dog-e-tox' dog-food.

Over a four-week period in March, a significant increase in specific growth-rate, expressed as percentage length per week $\frac{\ln L_{II} - \ln L_I}{T_2 - T_1} \times 100$, of the experimental fish over the controls was obtained.

Experimental fish :	Mean 0·7 per cent ;					stand. error of mean		0·06
Control fish :	,, 0·3 ,,	,,	,,	,,	,,	,,	,,	0·06
Unhandled fish (8 fish) :	,, 0·2 ,,	,,	,,	,,	,,	,,	,,	0·05

The experiment was repeated over four weeks in July using other fish, and a similar result was obtained.

Experimental fish :	Mean 1·1 per cent ;					stand. error of mean		0·09
Control fish :	,, 0·4 ,,	,,	,,	,,	,,	,,	,,	0·09
Unhandled fish :	,, 1·0 ,,	,,	,,	,,	,,	,,	,,	0·17

The adverse effect of handling on the growth-rate of the fish is well illustrated by the July results, when the unhandled fish grew at a much greater rate than did the controls.

Owing to the difficulty of accurately assessing the food intake of fish kept under hatchery conditions, it is impossible to determine whether or not the low growth-rate of the unhandled fish in March is a reflexion of a seasonal variation in the rate of secretion of an endogenous growth hormone. It is hoped to elucidate this point in further work.

D. R. Swift

Freshwater Biological Association,
Ferry House,
Ambleside, Westmorland.
Feb. 15.

[1] Pickford, G. E., and Thompson, E. F., *J. Exp. Zool.*, **109**, 367 (1948).

Effect of Mercury Vapour on the Active Uptake of Sucrose by Leaf Tissues

Although the poisonous action of mercury vapour on plants was noticed as far back as 1797[1], little attention has been paid to this compared with the action of mercury compounds. In 1934, Zimmerman and Crocker[2], investigating the damage done to roses by mercuric chloride applied to the soil, found that the effect was due to the formation of free mercury in the soil, the vapour of which attacked the shoot. In the course of studying the uptake of sucrose by floating leaf disks of *Atropa belladonna* (deadly nightshade) and *Lactuca sativa* var. *capitata* (lettuce), we have found that the active uptake is greatly reduced by the presence of free mercury.

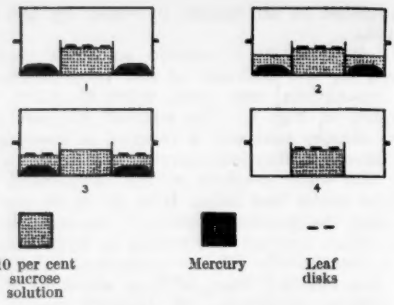


Fig. 1. Treatments used in the investigation of the effect of metallic mercury on the active uptake of sucrose by the leaf tissue of *Atropa belladonna*

The leaf disks were floated at 25° C. for 9 hr. on 10 per cent sucrose solution in Petri dishes placed inside closed vessels. Sucrose uptake, which was measured as increase in dry weight of the disks[3], had already been found to be considerably less in nitrogen than in air[4], and this difference was taken as a measure of the active uptake.

To investigate the effect of metallic mercury on active uptake, four treatments (illustrated in Fig. 1) were investigated: (1) mercury placed in the vessels around the Petri dishes; (2) mercury similarly placed but covered with sucrose solution; (3) disks floated on the sucrose solution covering the mercury; (4) no mercury present.

The surface area of mercury was the same in treatments (1)–(3). The uptake in nitrogen, which was found to be unaffected by these treatments, was subtracted from the results to give the active uptake in each case.

Each of these four treatments was performed in both light and dark, the experiments being conducted under fluorescent light with the vessels of the dark series made light-proof with paint. The experiment was replicated once and carried out on four occasions, so that a combined analysis of variance of the four experiments was possible. The results are shown in Table 1.

Table 1. Active Uptake of Sucrose (in mgm.) of Floating Leaf Disks of *Atropa belladonna* treated as in Fig. 1

	Treatment 1	2	3	4	Mean
Light	0·63	6·90	6·30	6·13	4·99
Dark	0·38	4·65	4·48	5·60	3·77
Mean	0·50	5·77	5·39	5·86	
Least significant differences ($P = 0·05$)	between means of light and dark treatments = 1·00				
	between means of treatments 1 to 4 = 1·42				

A free surface of mercury almost completely eliminated active uptake of sugar ($P = 0·01$), whereas if the mercury were covered by solution it had no inhibitory effect even when the tissue was floated on the covering solution. The effect, therefore, seemed to be due to the mercury vapour in the air over the disks. Uptake in light was greater than in the dark ($P = 0·05$), but light had no significant effect on the response to mercury vapour. The effects

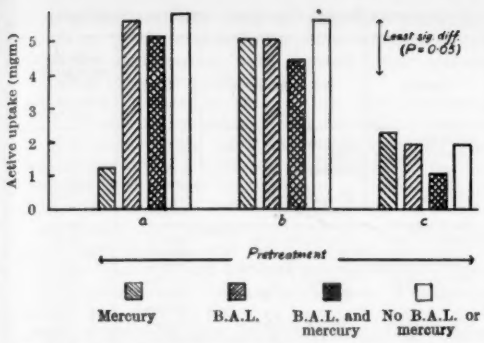


Fig. 2. Effect of the four treatments shown on the active uptake of sucrose by leaf disks of *Atropa belladonna* pretreated in three ways: (*a*) floated on water; (*b*) floated on B.A.L. solution (10^{-4} *M*); (*c*) floated on water in the presence of mercury vapour

of mercury on lettuce were similar but less marked than with *Atropa*.

It might be supposed that mercury vapour reacted with —SH groupings in some way essential to the active uptake of sugar[5,6]. If this were so, thiol compounds, if applied externally in sufficient concentration, might eliminate or even reverse this mercury inhibition. To test this possibility, British antilewisite (B.A.L.) was used. In this experiment the effects on active uptake of mercury vapour, B.A.L., and mercury vapour in the presence of B.A.L. were investigated on samples of disks each pretreated for 6 hr. in one of three ways: (*a*) floated on water alone; (*b*) floated on B.A.L. solution (10^{-4} *M*); (*c*) floated on water in the presence of mercury vapour. The results, shown diagrammatically in Fig. 2, represent the means of four values.

It will be seen that, after pretreatment by floating on water alone (*a*), the inhibitory effect of mercury treatment is completely eliminated by the presence of B.A.L., which has no significant effect by itself. With disks pretreated with B.A.L., (*b*), mercury treatment has no inhibitory effect even in the absence of B.A.L. during treatment. On the other hand, the uniformly low values of all treatments when the samples had been pretreated with mercury, (*c*), indicate that the mercury vapour had a lasting effect which could not be reversed by the presence of B.A.L.

These results lend support to the suggestion that the mercury vapour inhibited the active uptake of sugar by blocking in some way —SH groups closely associated with the uptake. They also show that it is possible to obtain an immediate and almost complete inhibition of an active process merely by exposure to mercury vapour, the presence of which may therefore constitute a possible danger in physiological experiments where mercury is used.

G. A. Pennell
P. E. Weatherley

Department of Botany,
University of Nottingham.
Feb. 10.

[1] Deiman, Paats, Van-Troostwyck and Lauwerenburgh, *Ann. chim.*, **22**, 122 (1797).
[2] Zimmerman, P. W., and Crocker, W., Contr. Boyce Thomson Inst., **6**, 167 (1934).
[3] Weatherley, P. E., *New Phytol.*, **52**, 76 (1953).
[4] Weatherley, P. E., *New Phytol.* (in the press).
[5] Barron, E. S. G., "Advances in Enzymology", **11**, 201 (1951).
[6] Janke, A., and Beran, F., *Pflanzsch. Ber.*, **8**, 161 (1952).

Boron Deficiency in Oil Palms in the Kasai Region of the Belgian Congo

Kovachich has described the symptoms, distribution and spread of little-leaf disease of the oil palm[1] and presented evidence to suggest that the disease is of physiological origin[1,2].

To determine whether little-leaf is due to a nutrient deficiency, an experiment was laid down in February 1953 on an area replanted in 1948 in an improved natural palmery, comprising comparisons between control, complete fertilizer (N, P, K, Mg, Ca, Cu, Mn, B, Zn, Ni, Co, Mo) and complete fertilizer with omission of one each of the twelve nutrients. The experiment is sited in the Kasai region of the Belgian Congo.

A disease census was carried out in June and December 1953. The last revealed that little-leaf disease was confined almost exclusively to the plots receiving complete fertilizer with omission of boron. The accompanying table shows the number of affected palms per treatment, each comprising sixty-four palms.

Control (no fertilizer)	2
Complete fertilizer	1
„ „ without molybdenum	0
„ „ „ cobalt	2
„ „ „ nickel	0
„ „ „ zinc	2
„ „ „ boron	34
„ „ „ manganese	0
„ „ „ copper	0
„ „ „ calcium	1
„ „ „ magnesium	0
„ „ „ potash	4
„ „ „ phosphate	4
„ „ „ nitrogen	1

It appears that, ten months after the fertilizer applications were made, 53 per cent of the palms on the plots without boron showed external symptoms of little-leaf disease, as compared with 0–6 per cent on the control plots and those receiving boron. This would seem to indicate that, in the majority of cases, little-leaf disease is directly related to boron deficiency. The presence of a number of isolated cases of little-leaf on the plots receiving other treatments suggests that similar symptoms may be due to insect damage.

J. D. Ferwerda

Research Department,
Huilever S.A.,
Yaligimba-lez-Bumba,
Belgian Congo.

[1] Kovachich, W. G., *Trop. Agric. Trin.*, **29**, 107 (1952).
[2] Kovachich, W. G., *Trop. Agric., Trin.*, **30**, 61 (1953).

A Virus Latent in Carnation and Potato Plants

While studying virus diseases of the carnation (*Dianthus caryophyllus* L.), three different viruses were readily identified by the symptoms they cause in this plant and in sweet william (*Dianthus barbatus* L.). Attempts to use serology to identify these viruses at first gave conflicting and confusing results, for specific reactions were sometimes obtained with sap from plants known to be infected with unrelated viruses. This became explicable when it was found that some stocks of symptomless carnations contain an antigen that is transmissible to sweet william by inoculation of sap and by the aphid *Myzus persicae*. Infected sweet william plants show no

symptoms, but the multiplication of the antigen in them can readily be identified by serological tests or by electron microscopy. This antigen has also been transmitted to some other species of plants; however, the only one in which it has caused any symptoms, and so justifies calling it a virus, is sugar beet, the older leaves of which sometimes become yellow.

Some of the properties of the virus *in vitro* have been measured by making serological tests on the sap extracted from sweet william plants a month after they were inoculated. Sap from sweet william loses infectivity when diluted more than 1/1,000, the thermal inactivation end-point is between 60° and 65° C., and the longevity *in vitro* at 20° C. is between two and three days. Sap from the infected sweet william plants contains rod-shaped particles, about 10 mμ wide and of varying lengths. These particles closely resemble those previously described in King Edward plants carrying potato paracrinkle virus, which like the carnation virus can infect a range of plants without causing symptoms[1]. Because of these similarities, sap from various potato varieties was tested for its ability to precipitate specifically with the antiserum prepared against the carnation virus. These tests showed that many apparently healthy stocks of potato contain an antigen related to the latent carnation virus. This was not confined to the variety King Edward, which carries potato paracrinkle virus, but was found in plants of the varieties Gladstone, Craig's Alliance, Majestic, Arran Victory, Epicure and U.S. Seedling 41956. Too few tests have yet been made to know how widespread is this virus in potato stocks, but its occurrence in most of the plants already tested suggests that it must be fairly common. In this respect, at least, it resembles a virus recently reported from Holland that is carried symptomlessly by most potato varieties[2].

B. Kassanis

Rothamsted Experimental Station,
Harpenden, Herts.
Feb. 15.

[1] Bawden, F. C., Kassanis, B., and Nixon, H. L., *J. Gen. Microbiol.*, **4**, 210 (1950).

[2] De Bruyn Outboter, M. P., Proc. Conf. Potato Virus Diseases, Wageningen-Lisse (1951). Rozendaal, A., *Meded. N.A.K.*, **8**, 94 (1952).

Steroidal Sapogenins in Amazonian Plants

The relatively simple method of analysis recently described by Wall, Eddy, McClennan and Klumpp[1] for the analysis of plant samples for steroidal sapogenins inspired me to search for them in the rich Amazonian flora. Dr. João Murça Pires, chief of the Botanical Section of this Institute, collected various plant samples which might contain steroidal sapogenins. The results of analysis are given in the accompanying table. Every plant analysed contains more than 0·2 per cent sapogenins. Some of the plants occur in Amazonia in abundance. The 'aninga' (*Montrichardia arborescens*), for example, is growing so luxuriantly on the banks of the rivers that sometimes the plants represent real obstacles to navigation.

Further work is in progress, and search continues for steroidal sapogenins, which will be identified spectrophotometrically[2]. The results will be published in full elsewhere.

Amazonian Plants containing Steroidal Sapogenins

Family	Scientific name	Part	Sapogenins calculated on absolutely dry material (per cent)
Alismaceae	*Sagittaria* sp.	leaves	0·74
Amarylidaceae	*Fourcroya*	leaves	0·83
,,	*Smilax* sp.	tubers	0·47
		roots	0·50
Araceae	*Montrichardia arborescens*	leaves	0·69
		stalks	0·69
Bignoniaceae	*Jacaranda copaia*	bast	0·43
Connaraceae	*Rourea ligulata*	leaves	0·59
		twigs	0·46
Convolvulaceae	*Ipomoea fistulosa*	twigs	0·29
Dioscoreacea	*Dioscorea* sp.	tubers	1·65
Iridaceae	*Eleutherina plicata*	leaves	0·54
		tubers	0·68
Leguminosae	*Clitoria javitensis*	leaves	1·29
		roots	1·10
,,	*Derris latifolia*	leaves	0·75
		roots	0·64
,,	*Derris negrensis*	leaves	1·69
		twigs	0·84
,,	*Derris pterocarpa*	leaves	0·80
		roots	0·91
,,	*Derris reviflora*	leaves	1·28
		roots	1·16
,,	*Derris urucú*	leaves	0·57
		roots	0·97
,,	*Derris utilis*	leaves	0·49
		roots	0·73
,,	*Pithecolobium cauliflorum*	bast	2·31
Malphigiaceae	*Stigmaphyllon fulgens*	leaves	0·43
		twigs	0·51
,,	*Mascagnia sepium*	leaves	0·24
		twigs	
Malphioceae	*Banisteria caapi*	leaves	0·57
		twigs	0·66
Sapindaceae	*Sapindus saponaria*	fruit-pulp	1·05

I wish to acknowledge my indebtedness to Felisberto C. de Camargo, director of the Serviço Nacional de Pesquizas Agronômicas of the Brazilian Ministry of Agriculture, for his interest in this work, and for permission to publish the results obtained. Thanks are also due to M. E. Wall, J. M. Pires and Luiz Mergulhão.

R. F. A. Altman

Chemical Section,
Instituto Agronômico do Norte,
Belém, Brazil.
Jan. 23.

[1] Wall, M. E., Eddy, C. R., McClennan, M. L., and Klumpp, M. E., *Anal. Chem.*, **24**, 1337 (1952).

[2] Cf. Eddy, C. R., Wall, M. E., and Klumpp Scott, M. E., *Anal. Chem.*, **25**, 266 (1953).

Observations on the Iodo-Amino-Acids of Marine Algae using Iodine-131

Iodine has been reported to occur in marine algae as inorganic iodide and iodo-tyrosines[1]. Both forms are known to produce artefacts under chromatographic examination[2,3]. It therefore appeared desirable to examine the chemical stability of the iodine atoms in iodo-amino-acids and their exchangeability with radioactive iodide under the conditions of hydrolysis with barium hydroxide before attempting to investigate the metabolism of iodine fixation in the algae.

The chemical stability of the compounds was found by comparing chromatograms of the substances remaining after barium hydroxide treatment with those of the starting materials, the acids being made visible by spraying with ninhydrin. The exchangeability of the iodine atoms was determined by autoradiography. If simple exchange occurred, radio-

active spots were detected in positions coincident with those of the original materials, whereas if new radioactive compounds were formed their activity was found in other positions.

Milligram quantities of tyrosine, diiodotyrosine, thyronine, diiodothyronine, triiodothyronine, thyroxine, dibromotyrosine and dibromothyronine were boiled under reflux for 18 hr. with saturated barium hydroxide and a few microcuries of iodine-131 as iodide. In each case (after precipitation of barium as carbonate) the reaction mixture was separated chromatographically with an *n*-butanol/dioxane/2 *N* ammonia mixture[4], and the positions of labelled compounds determined. On every occasion iodide was strongly detected in the final mixture; but, with tyrosine, principally monoiodotyrosine and also traces of three unknowns were found. Labelled diiodotyrosine, together with traces of an unknown, and monoiodotyrosine were formed from the parent diiodotyrosine[5]. A large range of labelled materials, including the monoiodo- and diiodo-tyrosines, was derived from thyronine, but labelling of the compound occurred only with diiodothyronine. Triiodothyronine seemed to be mainly changed to the diiodo- compound, and both these substances were labelled. The iodo groups of thyroxine appeared to be stable on treatment with alkali, but with 6 *N* hydrochloric acid were readily labelled. Dibromotyrosine, in the presence of labelled iodide, produced a strong spot in a new position believed to be due to iodo-bromotyrosine, while dibromothyronine probably gave some diiodo- and iodo-bromothyronine. The solvent employed could not separate these latter substances from the parent dibromothyronine.

If any of the above substances, with the exception of thyroxine, were present in their free state within marine algae, they ought to be detected as labelled compounds on hydrolysing the finely minced algae with barium hydroxide in the presence of iodine-131. In accordance with this view, a few grams each of *Rhodymenia palmata*, *Laminaria digitata* (stipe and frond), *Fucus vesiculosus* and *Ulva lactuca* were individually reduced to a fine slurry with a serrated roller and plate. 10 c.c. of water and 5 gm. of barium hydroxide were added, together with a few microcuries of iodine-131, and the whole boiled under reflux for 18 hr. As before, excess barium was precipitated as carbonate, which was removed, together with the weed residue, by centrifuging. After acidification with 2 c.c. of 6 *N* hydrochloric acid, the solution was extracted with two 10-c.c. portions of butyl alcohol. These combined extracts were evaporated to dryness, taken up in a few drops of methyl alcohol and chromatographed as previously. All chromatograms yielded two radioactive spots, one corresponding to iodide, the other being a fast-moving spot about R_F 0·9 (cf. Acland[3]).

For comparison, samples of the above algae, which had been maintained in sea water containing iodine-131 for one week, were minced and hydrolysed as before. In the case of *L. digitata*, the stipe and frond were treated separately. Radioactive iodide was present in each chromatogram, being the sole constituent in the *L. digitata* stipe. In addition, *F. vesiculosus* contained a small trace of the fast-moving spot about R_F 0·9. *R. palmata*, *U. lactuca* and *L. digitata* (frond) had activity in the position of mono- and di-iodotyrosine and a trace of a substance at the same R_F as that produced by the action of iodide on dibromotyrosine. Both *R. palmata* and *U. lactuca* also possessed traces of a substance in the position of triiodothyronine. In *U. lactuca* the fast-moving spot at R_F 0·9 was strongly represented.

With the exception of *L. digitata* stipe and *F. vesiculosus*, these results appear to support the view that iodine is metabolically incorporated in marine algae. It is difficult to appreciate why iodo-amino-acids, presumably liberated during direct hydrolysis of the algae in the presence of labelled iodide, were unlabelled, in view of the ease with which this occurs in the absence of algal residue. The difference between stipe and frond of *L. digitata* is of sufficient significance to warrant further study.

I wish to acknowledge the technical assistance of Mr. G. Thomson in the course of this work. I thank Dr. C. B. Coulson and Mr. N. Brownbridge for helpful discussions.

RICHARD SCOTT

Institute of Seaweed Research,
Inveresk, Midlothian.
Feb. 4.

[1] Eschle, *Z. physiol. Chem.*, **23**, 30 (1897). Kylin, H., *Z. physiol. Chem.*, **186**, 50 (1929). [2] Masuda, E., and Nishida, K., *J. Pharm. Soc. Japan*, **54**, 952 (1934). Roche, J., and Lafon, M., *C.R. Acad. Sci., Paris*, **229**, 481 (1949).
[3] Acland, J. D., *Nature*, **170**, 32 (1952).
[5] Stanley, P. G., *Nature*, **171**, 933 (1953).
[4] Gross, J., Leblond, C. P., Franklin, A. E., and Quastel, J. H., *Science* **111**, 605 (1950).
[6] Miller, W. H., Anderson, G. W., Madison, R. K., and Salley, D. J., *Science*, **100**, 340 (1944).

Occurrence of *Durvillea caepestipes* on Chatham Island

A BELT of *Durvillea* is a conspicuous feature of the upper sub-littoral to lowermost littoral zone of the coast of Chatham Island, as is usual in southern waters. On those parts of the coast visited, the dominant species is one with a solid lamina and not the *D. antarctica* (Chamisso) Hariot which is the dominant species on the coasts of New Zealand approximately five hundred miles to the west.

One well-grown plant had a simple, conical attaching disk about 4 in. in diameter, and an 8-in. long stipe which gradually flattened into a fan-like expansion about 2 ft. across at its broadest point and gave rise to four thongs. These rapidly widened to 18 in. and were about 24 ft. long. One of them forked once; but the remainder were undivided. At no point along the entire length of the plant was there any sign of inflation, the thongs being about ½–¾ in. thick. Some of the plants were rather more subdivided than this and approached *D. antarctica* in general form. Many were less divided, and often the plants consisted of a single blade up to 4 ft. wide. Although many of the plants reached a length of 20 ft. or more, the majority were only about 8–10 ft. long.

Apart from the simple nature of the attaching disk, these plants agree well with Hooker's[2] description of *D. harveyi* Hook. fil., and with Skottsberg's[3–5] accounts of this species. Skottsberg, moreover[4], was unable to find any trace of the anastomosing holdfast described by Hooker, and I think that such an appearance may be due to the burrowing of molluscs, etc., into the primarily simple disk.

Skottsberg[4] states *D. harveyi* Hook. fil. and *D. montagnei* Aresch. to be a single species which, on grounds of priority, should be named *D. caepestipes* (Mont.). In a later paper, however[5], he reverts to the usage of *D. harveyi* Hook. fil. In this paper

D. caepestipes (Mont.) Skotts. is used for the Chatham Island plant, which is believed to be identical with the *D. harveyi* of Hooker and Skottsberg.

D. antarctica (Chamisso) Hariot also grows on Chatham Island. On a reef about two miles south of Waitangi both species are found. The sides of the reef are fringed with the *D. caepestipes*, while on the seaward side of the reef is a more or less clear-cut belt of *D. antarctica* extending for about 10 ft., growing in the lower littoral above the *D. caepestipes*. The *D. antarctica* is readily distinguishable on account of the strongly inflated and much more laciniate laminæ—the thongs were often only about 1 in. wide and almost circular in cross-section. Even quite young plants could be easily distinguished. *D. antarctica* could also be seen growing above the *D. caepestipes* on a small isolated rock not far from the reef. Skottsberg[5] also found the two species occurring together in similar relative positions.

All the *D. antarctica* found was of the extreme laciniate form, and the occurrence within a few feet of each other of the extreme laciniate form of *D. antarctica* and completely undivided plants of *D. caepestipes* indicates that the two are not, as has been suggested[1,4,5], just different habitat forms of a single species.

Only a small part of the south end of Chatham Island was visited. On the west, at Waitangi, only *D. caepestipes* was found, and for several miles to the south there was abundant *D. caepestipes* and only occasionally *D. antarctica*. On the east coast, from Manukau Point to Owenga, only *D. caepestipes* was seen growing, often with *Lessonia variegata* J. Ag.—in the Magellanian region Skottsberg[5] often found it growing with *L. nigrescens* Bory. Judging from the very small amount of *D. antarctica* seen in the drift compared with the large quantities of *D. caepestipes*, the latter may well prove to be the dominant species throughout the island.

D. caepestipes (Mont.) Skotts. is also recorded from the region of the Magellan Straits, from Cape Horn, Hermite Island, the Falkland Islands and Kerguelen Land. This present record from Chatham Island indicates a circumpolar distribution of this species.

Margaret Naylor

Botany Department,
Otago University,
Dunedin,
New Zealand.
Jan. 28.

[1] Herriott, E. M., *Trans. and Proc. N.Z. Inst.*, **54**, 549 (1923).
[2] Hooker, J. B., "Botany of the Antarctic Voyage", I. "Flora Antarctica II", 456, and Pl. clxv (1847).
[3] Skottsberg, C., Wiss. Ergeb. Schwed. Sudpolar Exped. 1901, **3** (1907).
[4] Skottsberg, C., *Svensk. Vet. Akad. Handl.*, **61**, No. 11 (1921).
[5] Skottsberg, C., *Kungl. Svensk. Vetenskapsakad. Handl.*, 3 Ser., 19 (1941).

A Liquid Medium for the Cultivation of *Trypanosoma cruzi*

Media generally employed for the cultivation of hæmoflagellates are either semi-solid or of the diphasic type (a solid base and a liquid overlay) containing blood or blood elements[1,2]. Thus they are complex both in chemical composition and in physical properties.

While engaged in a study of the nutrition of hæmoflagellates, we developed a liquid medium, simple in composition, which permits quantitative analysis of growth requirements.

As a starting point, a medium previously used for cultivation of fastidious bacteria[3] was considered; in that medium, tomato juice successfully replaced more complex sources of growth factors (such as meat extract, serum or blood)[4].

In the present medium, the specific requirements of *Trypanosoma cruzi* are supplied by hæmatin[5], a purified fraction of serum albumin and a small amount of tomato juice. The medium is a clear solution of relatively simple and reproducible composition which is given in Table 1.

Table 1. Composition of the *T. cruzi* Medium

I.	Salts: NaCl	0·4 per cent
	$Na_2HPO_4.12H_2O$	0·3 ,,
	KH_2PO_4	0·05 ,,
II.	Casein hydrolysate*	1·0 ,,
III.	Hæmatin	10 μgm./ml.
	Bovine albumin (Armour, fraction V)	0·5 mgm./ml.
	Tomato juice†	3·0 per cent

* A product of Bios Laboratories, Inc., purified by adsorption on charcoal (2 per cent) at *p*H 4·5.
† The juice is squeezed out of ripe tomatoes strained through gauze, filtered through paper and then Seitz filter.

Ingredients (I) and (II) are dissolved in distilled water, reaction adjusted to *p*H 7·8 and the medium autoclaved at 15 lb. pressure for 20 min. The remainder (III) are Seitz-sterilized and added to the autoclaved medium (final concentration as indicated above). Penicillin and streptomycin (100 units/ml. of each) may be included to reduce the risk of bacterial contamination.

The medium is dispensed in 5 ml. quantities into 18 mm. × 150 mm. test tubes. After inoculation the culture is incubated at 28° C. in a slanted position. The growth is diffuse, but in time a sediment forms which is resuspended by shaking for photometric measurements.

When starting with a 5 per cent inoculum (about 1 million cells per ml.), the maximum turbidity (optical density 0·25–0·35; read on a Coleman junior spectrophotometer, at wave-length 650 mμ, against a blank of sterile medium) is reached in about twenty days. This corresponds to a hæmacytometer count of 40–55 million organisms per ml., which is comparable to the results obtained with blood containing diphasic media[1,2], and is 5–100 times higher than in diphasic media in which partial elimination of some blood constituents has been attempted[6,7] (the estimation of growth on semi-solid media is not reliable enough for quantitative comparison). *T. cruzi* has been carried on this medium for more than a year, with no diminution in growth. Three-weekly transfers are usually made, but the organisms remain viable and motile for much longer.

One striking feature of the new medium is the heavy growth obtained in spite of elimination of particulate matter necessary for equally good growth in other media. Apart from simplicity in preparation, the medium offers considerable advantages for the study of hæmoflagellates. (The medium permits heavy growth of *Leishmania tropica* and may prove adequate for the propagation of other organisms of this group. The specific requirement of *L. tropica* for serum albumin has, incidentally, been recognized in an early work by Adler and Ashbel[8].)

The absence of non-soluble components enables the measurement of trypanosomal growth by the usual turbidimetric procedures. Furthermore, the relatively simple composition of the medium renders it suitable

for analysis of chemical and antigenic structure, and for *in vitro* evaluation of trypanocidal agents.

The development of this medium proved a promising starting point for a complete analysis of the nutritional requirements of *T. cruzi*. Experimental evidence, which will be published elsewhere, indicates that the tomato juice may be replaced by known growth factors and that the function of the serum albumin in our medium depends on its highly specific capacity to bind certain essential lipids (for example, unsaturated fatty acids)[8] which are trypanolytic *per se*.

Thus the well-established dependence of these hæmoflagellates on certain blood fractions may be explained by the surface action of such blood lipids which facilitate the absorption of known growth factors.

We are indebted to Prof. S. Adler for the strains employed in this work and for his constant interest.

Nathan Citri
Nathan Grossowicz

Department of Bacteriology,
Hebrew University–Hadassah Medical School,
Jerusalem.
Jan. 27.

[1] Chang, S. L., *J. Inf. Dis.*, **80**, 164 (1947).
[2] Seneca, H., and Henderson, E., *Amer. J. Hyg.*, **53**, 17 (1951).
[3] Grossowicz, N., and Kligler, J. J., *Amer. J. Pub. Health*, **32**, 745 (1942).
[4] Grossowicz, N., *Proc. Soc. Exp. Biol. and Med.*, **49**, 8 (1942).
[5] Lwoff, M., *C.R. Soc. Biol.*, **107**, 1234 (1931).
[6] McRary, W. L., Noble, E. R., and Tondevold, E. L., *Science*, **115**, 288 (1952).
[7] Little, P. A., and SubbaRow, Y., *J. Bact.*, **50**, 57 (1945).
[8] Luck, J. M., in Disc. Farad. Soc., **6**, 44 (1949).
[9] Adler, S., and Ashbel, R., *Arch. Zool. Ital.*, **20**, 66 (1934).

A Toxic Nitro Compound from *Streptomyces thioluteus*

A large amount of a yellow crystalline compound which is very toxic to animals has been obtained from cultures of *Streptomyces thioluteus*[1]. This compound (I) has been found to contain a nitro group.

The molecular formula of the compound (m.p. 158°) corresponded to $C_{21}H_{21}O_6N$. Spectroscopic data obtained in ethanol were as follows: $\lambda_{max.}$ 256 mμ (log ε, 4·37); 345 mμ (log ε, 4·26). The nitro group test[2] with ferrous ammonium sulphate was positive. Clemmensen reduction of I gave white crystals, m.p. 210–5° (II), with a positive test for an aromatic amino group.

Acid hydrolysis with alcoholic 1*N* hydrochloric acid converted I into yellow needles of melting point 194–5° (III), which showed a positive test for the nitro group. A yellow acetate (m.p. 182–4°, IV) and a white reductive acetate (m.p. 216–8° (dec.), V) of these yellow needles were also prepared. Reductive acetylation of IV gave V, and acetylation of II also gave V. The number of acetyl groups in IV and V were 1 and 2, respectively.

Oxidation of compound III with alkaline permanganate yielded white crystals, melting point 234–5° (in sealed tube), with the composition $C_7H_5O_4N$ (VI). This compound showed $\lambda_{max.}$ 260 mμ (log ε, 4·03) in ethanol and gave positive tests for the nitro group and carboxyl group. Methylation with diazomethane converted compound VI into white plates, melting point 92–3°, which gave no melting point depression upon admixture with methyl *p*-nitrobenzoate.

In the infra-red spectrum two bands corresponding to a nitro group attached to an aromatic nucleus, that is, around 6·3 and 7·5 μ, were present in compounds I, III and IV, and ArNHCO— bands at 5·94 and 6·52 μ were present in V.

Hence, I has the partial structure

We are grateful to Dr. K. Iwadare, of the Banyu Pharmaceutical Co., who has generously provided us with material.

Yoshimasa Hirata
Kunio Okuhara

Department of Chemistry,
Nagoya University,
Chikusa-ku, Nagoya,
Japan.

Takayuki Naitô

Banyu Pharmaceutical Co.,
Okazaki, Japan.

[1] Maeda, K., *J. Antibiotics*, **6**, 137 (1953).
[2] Hearon, W. M., and Gustauson, G., *Indust. Eng. Chem., Anal. Ed.*, **9**, 352 (1937).

Occurrence of Susceptibility to Carbon Dioxide in *Drosophila melanogaster* from Different Countries

Until recently, all virus-induced susceptibility to carbon dioxide of *Drosophila melanogaster*[1] seemed derived from one stock, and repeated search for another occurrence in many laboratory stocks remained unavailing. Some years ago, one of us (F. T.) discovered that *D. melanogaster* flies, recently trapped in the neighbourhood of Rothamsted Experimental Station, Harpenden, Herts, showed the characteristic hereditary carbon dioxide susceptibility, but as the other of us (H. K.) had kept at Rothamsted a few years earlier a substrain of L'Héritier's original stock, it was impossible to be sure that an escape was not responsible. However, a recent report has made it clear that carbon dioxide-susceptible flies, far from being rare, occurred in about one-third of all freshly trapped strains of *D. melanogaster* in France[2]. In addition, we are indebted to a personal communication from Prof. L'Héritier in which he states that he found susceptible flies in cultures from Israel but could not detect the susceptibility in flies from Africa or Japan.

In our own investigation, single flies trapped by ourselves, their offspring or flies supplied by other institutions were bred in vials at 24° C. and tested about one week after emergence. *D. melanogaster* is often transported with fruit, and the place of trapping need not necessarily be the place of origin. The results are summarized in Table 1.

It can be seen from the above results that carbon dioxide susceptibility occurs widely, but that flies from the same locality may sometimes be carbon dioxide-susceptible and sometimes carbon dioxide-resistant. The virus responsible for the susceptibility seems to be lost more or less quickly under laboratory conditions, which probably accounts for the fact that the susceptibility has not been rediscovered before.

The great differences among the resistant females from different strains in the rates of infection by susceptible males are probably due to some genetical and cytoplasmic[3] properties of these strains, but it is at present difficult to correlate these with any environmental factor.

Table 1. Survival of Progenies* from Single Females after Exposure for 1 min. to Carbon Dioxide at a Flow-Rate of 3–4 ml./sec. at 12–14° C.

Places of trapping	Generations in laboratory	No. of progenies where all flies were killed	all flies recovered	some flies were killed†	Percentage and standard error of susceptible flies from crosses of resistant ♀♀ with standard susceptible ♂♂ ‡
Southampton, Hants.	3	—	12	—	10·74±1·99
Benenden, Kent	2	—	14	—	4·74±1·46
Harpenden, Herts (1)	1	—	11	—	0
,, ,, (2)	1	2	9	3	7·78±1·67
,, ,, (3)	1	—	12	—	7·45±1·56
Oxford (51)	about 50	—	10	—	76·92±4·77
,, (52)	,, 25	11	—	2	67·02±4·85
,, (53)	1	3	3	4	37·73±3·27
Edinburgh	about 60	3	6	4	16·00±3·28
Glasgow	2	—	13	—	14·66±3·28
Crianlarich, Perthshire	about 60	8	2	2	93·55±1·44
Renfrew, Renfs.	,, 60	—	12	—	9·25±1·58
Oberhofen, Switz.	1	—	11	4	12·84±2·27
Ischia, Italy	about 25	3	8	2	6·45±2·21
Brazil—					
São Paulo	,, 25	1	3	6	76·85±4·06
Belo Horizonto	,, 25	—	9	—	5·93±1·44
Floriano	,, 25	—	10	—	1·86±1·06
Salvador	,, 25	—	10	—	14·05±2·56
Cornelio Procopio	,, 25	—	9	—	18·71±2·98

* The average number of flies tested in a progeny was 22·16±7·95, the minimum number 11.
† At least two flies died after treatment.
‡ High susceptibility of this strain was maintained by periodic selection.

It should be mentioned that two trapped strains, which were shown by crossing to be *D. simulans*[4], were not susceptible.

We wish to thank the numerous colleagues who assisted us by trapping and forwarding flies.

H. Kalmus

Galton Laboratory,
University College, London.

Jill Kerridge
F. Tattersfield

Department of Insecticides and Fungicides,
Rothamsted Experimental Station,
Harpenden, Herts. Feb. 23.

[1] Teissier, G., and L'Héritier, Ph., *C.R. Acad. Sci., Paris*, **205**, 1099 (1937); **206**, 1193, 1683 (1938).
[2] Brun, G., L'Héritier, Ph., and Plus, N., "Le virus héréditaire de la Drosophile", VI Congr. Int. di Microbiologia, Roma, **12**, 781 (1953).
[3] Brun, G., ref. in L'Héritier, Ph. Cold Spring Harbor Sympos., **16** (1951).
[4] Sturtevant, A. H., Carnegie Inst. Pub. No. 399 (1929).

"Social Conditions and the Development of Science"

Prof. H. Dingle's review in *Nature* of May 1, p. 791, of "Essays on the Social History of Science" contains two serious misrepresentations of fact which it is my duty to set right as chairman of the Commission instrumental in the production of the book. After quoting a sentence from the introduction, in which I presented as my personal view a definite conception of the fundamental trend of social evolution and the position of science in it, Prof. Dingle suggests that "the editor's team includes a goodly company of brave men prepared to follow the trumpet-call wherever it leads them". Certainly Prof. Dingle would not have written this if he had not somehow overlooked the very text from which he extracts a fragment. I write, in fact, on page 10, just before coming to the above-mentioned statement: "It goes without saying that the contributors have been left entirely free to choose their subjects and to decide upon the best ways of treating them. The Commission has no preconceived views to advocate. As a matter of fact, there is little probability that unanimity of agreement would be found among its members on many of the points made by the contributors to this volume. The Commission acts on the view—which is a vital requirement for fruitful scientific enquiry—that the truth can only impose itself by its own strength and that the greatest disservice which can be done to it is to try to force evidence into any rigid system". Further, I must beg leave to reproduce the passage immediately following the one quoted by Prof. Dingle: "I regret that so many prominent scholars are too timid to accept this general inference as a guidance in their studies, because I feel that they are thereby depriving themselves of a fruitful instrument of research. However, it is only by further careful and dispassionate analysis of more and more evidence that this issue can be decided. Thus it is on this task of the detailed analysis of concrete cases of social and scientific development that our efforts should be concentrated at the present time. At this stage the general outlook of the investigator matters comparatively little provided he controls it sufficiently to prevent it from obscuring his judgment."

The other point in Prof. Dingle's review to which I take exception most strongly is his attempt to link up the book with the advocacy of State control of science, which he represents as a dire menace to scientific activity. He suggests, in effect, that once science is recognized as essentially a social matter, it is thereby implied that it is "properly subject to control by the State". It is true that he immediately adds: "The writer [of the essay he is criticizing] does not here take this final step", but he proceeds to say that "he makes it almost irresistible", and closes the sentence with the unhappily ambiguous statement: "and others have taken it". I should like to make it quite clear that no such consideration has ever been contemplated in the production of the book. The idea that its publication could have any relation to the question of State control of science is a figment of Prof. Dingle's imagination.

L. Rosenfeld

Department of Theoretical Physics,
University of Manchester.

I conceive the reviewer's task to be that of presenting the main character and purport of a book, and, if there is an appreciable weight of material of another character, to state that fact. This I did. I did not say that those who followed the trumpet-call were *constrained* to do so.

I did not say or imply that the book was produced with the object of furthering State control of science. My point was that its tendency was such as to facilitate that event. I see nothing ambiguous in the statement which Prof. Rosenfeld so describes, though the fact is, alas, unhappy enough. All menaces are figments of the imagination until they materialize: it is then too late to oppose them.

Herbert Dingle

University College,
London, W.C.1.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 7

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. H. Bondi and Prof. E. O. Kapp: "Theories About the Origin and Disappearance of Matter".

Tuesday, June 8

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 8.15 p.m.—Mr. W. Watson: "Recent Work in Archæology outside Europe" (5)—"China".

Tuesday, June 8—Friday, June 11

TEXTILE INSTITUTE, and the SOCIETY OF DYERS AND COLOURISTS (at the Grand Hotel, Scarborough, and the Spa Theatre, Scarborough).—39th Annual Conference—"Colour and Textiles".

Wednesday, June 9

ASLIB (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 4 p.m.—Annual General Meeting.

UNIVERSITY COLLEGE LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Prof. John R. Pappenheimer (Harvard Medical School): "A Theory for Renal Hæmodynamics".*

Thursday, June 10—Saturday, June 12

BRITISH SOCIETY OF RHEOLOGY (at the Mechanical Engineering Research Laboratories, Department of Scientific and Industrial Research, East Kilbride, near Glasgow)—Conference on "Rheology in Mechanical Engineering".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

EXPERIMENTAL OFFICER to assist in work on the transmission of plant viruses—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (June 10).

ASSISTANT IN PSYCHOLOGY—The Secretary of University Court, The University, Glasgow (June 12).

BRITISH TITAN PRODUCTS FELLOW (graduate of a university in the British Commonwealth, and likely through research to contribute to knowledge in the field of inorganic chemistry)—The Registrar, King's College, Newcastle-upon-Tyne (June 12).

EXPERIMENTAL OFFICERS (with at least H.S.C. (science) or equivalent) IN THE RADIO DIVISION of the Royal Aircraft Establishment, Farnborough, Hants, for work concerned chiefly with the development of electronic equipment, radio frequency measurements at centimetric wave-lengths, and for other detailed technical investigations—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.289/54A (June 12).

LECTURER (with a good honours degree in chemistry and suitable teaching experience, and preferably with research, industrial, or other special experience in pure or applied chemistry) IN CHEMISTRY—The Principal, Acton Technical College, High Street, Acton, London, W.3 (June 12).

LECTURER (with an honours degree in chemistry, and with experience in industry, teaching or research) IN CHEMISTRY—The Principal, Wigan and District Mining and Technical College, Wigan (June 12).

LECTURER (with special qualifications in pure mathematics) IN MATHEMATICS—The Secretary, University of Durham, 38 North Bailey, Durham (June 12).

LECTURER IN CIVIL ENGINEERING—The Registrar, The University, Sheffield (June 14).

DEMONSTRATOR IN PHYSICS, and a DEMONSTRATOR IN GEOGRAPHY—The Registrar, University College, Keele, Staffs (June 15).

LECTURER IN EXPERIMENTAL PHYSICS—The Secretary of University Court, The University, Glasgow (June 15).

LECTURER (with a good honours degree, and preferably with a special interest in biophysics or biomolecular structure) IN PHYSICS, and an ASSISTANT LECTURER (with a good honours degree) IN PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (June 18).

ASSISTANT IN ZOOLOGY, and an ASSISTANT IN AGRICULTURAL ZOOLOGY—The Secretary of University Court, The University, Glasgow (June 19).

CHEMIST (with a degree, or considerable experience, not necessarily in sewage purification), to undertake analytical and other work in sewage purification—The Engineer to the Birmingham Tame and Rea District Drainage Board, Rookery Park, Erdington, Birmingham 24 (June 19).

ASSISTANT LECTURER IN PHYSICS—The Principal, Royal Holloway College, Englefield Green, Surrey (June 21).

LECTURER (with special qualifications in Romano-British archæology, and preferably with interests in western early medieval archæology) IN ARCHÆOLOGY—The Registrar, The University, Manchester (June 21).

RESEARCH DEMONSTRATOR IN BOTANY AND ZOOLOGY—The Registrar, University College, Singleton Park, Swansea (June 21).

LECTURER (with an honours degree and practical or research experience in either civil or mechanical engineering) IN ENGINEERING—The Secretary, The University, Aberdeen (June 22).

CHAIR OF AGRICULTURE tenable at Wye College, near Ashford, Kent—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 23).

ASSISTANT LECTURER (with special qualifications in applied mathematics) IN MATHEMATICS—The Registrar, The University, Manchester (June 26).

ASSISTANT LECTURER (preferably with a knowledge of electrophysiology) IN PHYSIOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (June 30).

LECTURER IN BIOCHEMISTRY at University College, Dundee—The Secretary, The University, College Gate, St. Andrews (June 30).

LECTURER/SENIOR LECTURER IN AGRICULTURE at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, June 30).

SCIENTIFIC ASSISTANT (university graduate in science or agriculture, and preferably with special training in nutrition and/or knowledge of foreign languages) for duties which will include abstracting, indexing and proof reading—The Director, Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire (June 30).

SENIOR LECTURER (with a good honours degree in chemistry and research experience, preferably in soil science) IN SOIL SCIENCE AND CHEMISTRY, at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, Strand, London, W.C.2 (June 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (July 1).

READER or SENIOR RESEARCH FELLOW IN SOCIAL ANTHROPOLOGY, at the Australian National University, Canberra—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, July 1).

ASSISTANT LECTURER (primarily interested in the physiology of micro-organisms) IN THE DEPARTMENT OF MICROBIOLOGY—The Registrar, The University, Reading (July 2).

SENIOR LECTURER (preferably qualified and willing to develop research in geochemistry) IN GEOLOGY, at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, July 19).

SENIOR LECTURER or LECTURER (with at least a good honours degree) IN THE DAIRY HUSBANDRY DEPARTMENT, Massey Agricultural College, New Zealand, to lecture particularly on the improvement of dairy cattle—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, July 20).

PETROLEUM TECHNOLOGISTS, SENIOR TECHNICAL OFFICER (Ref. 171), and a TECHNICAL OFFICER (Ref. 46) (with at least a B.Sc. degree with chemistry and/or physics as a major subject, or equivalent qualifications, and experience in the field of petroleum products and solid fuels), IN THE FUELS AND LUBRICANTS LABORATORY, South African Bureau of Standards—The Secretary, South African Bureau of Standards, Private Bag 191, Pretoria, South Africa (July 21).

ASSISTANT, Grade A, to teach principally chemistry, with some mathematics or physics in ordinary national certificate courses—The Principal, North Lindsey Technical College, Kingsway, Scunthorpe, Lincs.

GEOGRAPHER (with an honours degree in geography or history, and preferably with a knowledge of Spanish or Norwegian) with the Falkland Islands Dependencies Scientific Bureau, for employment in London in work concerned with historical research on Atlantic place-names in connexion with current map production—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M3B/34385/TA.

GRADUATE ENGINEER or METALLURGIST (preferably with some works experience, and ability to drive a car) with the British Iron and Steel Research Association, Sheffield, to assist in dealing with works problems, trials of new processes, etc., in the iron and steel industry—The Personnel Officer, B.I.S.R.A., 11 Park Lane, London, W.1, quoting "Works Trials".

LABORATORY TECHNICIAN (preferably with experience in entomology or zoology) IN THE DEPARTMENT OF AGRICULTURAL SCIENCES—The Director, University of Nottingham School of Agriculture, Sutton Bonington, Loughborough.

LECTURER, Grade B, IN THE MATHEMATICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURER (graduate, preferably with a sound knowledge of statistics) IN THE DEPARTMENT OF MATHEMATICS, to teach to B.Sc. engineering and B.Sc. general degree standard; and an ASSISTANT, Grade B (with an honours degree in chemistry, and able to teach inorganic and physical chemistry to B.Sc. special chemistry degree standard, and preferably with industrial experience) in the School of Chemistry—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

PETROLEUM GEOLOGIST in the Department of Mineral Resources, Province of Saskatchewan—Mr. Graham Spry, Agent General for Saskatchewan, 28 Chester Street, Belgrave Square, London, S.W.1.

RESEARCH METALLURGIST (with a university degree and post-graduate experience of alloy steels or physical metallurgy, or higher degree without this experience), for work on high tensile alloy steels—The Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

RESEARCH SCIENTIST (B.Sc., preferably in physics, but chemistry degree considered, and at least two years laboratory experience in the use of X-ray diffraction techniques), for work on the assessment of mineral matter in coal and for the characterization of phases present in flame-side deposits occurring in coal-fired appliances—The Assistant Secretary, Ref. A.15, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

SENIOR CHEMICAL ENGINEER (A.R.I.C., A.M.I.Chem.E., honours degree or equivalent, with at least three years experience in an industrial research organization) IN THE DEPARTMENT OF ATOMIC ENERGY, Sellafield, Cumberland, to be responsible for a section concerned with the development of new chemical processes, including the design and operation of pilot plants—The Department of Atomic

Energy, Industrial Group Headquarters, Risley, Warrington, quoting 602.

Senior Experimental Officers (with at least H.S.C. (science) or equivalent, and considerable experience in the fields mentioned) in the Department of Atomic Energy, Sellafield, Cumberland, for (*a*) research work in applied physics on problems connected with the design and operation of nuclear reactors (Ref. 600); and (*b*) research work in applied chemistry on problems connected with the development of new chemical processes (Ref. 601)—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting appropriate Ref. No.

Senior Lecturer in the Department of Mathematics—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

Senior Scientific Officers (with at least a second-class honours degree, and three years postgraduate research experience in inorganic or physical chemistry) in the Department of Atomic Energy, Sellafield, Cumberland, for research work on problems connected with the development of new chemical processes associated with the atomic energy project—The Department of Atomic Energy Industrial Group Headquarters, Risley, Warrington, quoting 599.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The British Journal Photographic Almanac, 1954. Pp. 620+32 plates. (London: Henry Greenwood and Co., Ltd., 1954.) 7*s*. 6*d*. net.

National Smoke Abatement Society. Year Book, 1954. Pp. 52. (London: National Smoke Abatement Society, 1954.) 1*s*. [14

Proceedings of the Royal Society of Edinburgh. Section A (Mathematics). Vol. 64, Part 1 (No. 4): Expansion of a Finite One-dimensional Gas Cloud into a Vacuum. By Dr. A. G. Mackie. Pp. 57–70. 2*s*. 6*d*. Vol. 64, Part 1 (No. 5): Interpolatory Methods for Theorems of Vitali and Montel Type. By N. A. Bowen and A. J. Macintyre. Pp. 71–80. 1*s*. 6*d*. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) [14

Institute of Fuel. Report of the Council for the year 1953. Pp. 14. (London: Institute of Fuel, 1954.) [14

Ministry of Housing and Local Government. Interim Report of the Committee on Synthetic Detergents. Pp. 8. (London: H.M. Stationery Office, 1954.) 4*d*. net. [14

Wool Industries Research Association. Publication No. 199: Report of the Director of Research for 1953–54. Pp. 32. (Leeds: Wool Industries Research Association, 1954.) [14

Report of the Rugby School Natural History Society for the year 1953. Pp. 32+2 plates. (Rugby: George Over, Ltd., 1954.) [14

Chelsea Polytechnic, London, S.W.3. Fifty-Eighth Annual Report, Session 1952–53. Pp. 30. (London: Chelsea Polytechnic, 1954.) [14

Association of British Chemical Manufacturers. Proceedings of Work Study Conference, Buxton, 9–10th October, 1953. Pp. v+148. (London: Association of British Chemical Manufacturers, 1954.) Members 7*s*. 7*d*.; Non-members 12*s*. 6*d*. [14

Aero Research Technical Notes. Bulletin No. 135: Personnel Protection—Dermatitis. Pp. 4. (Duxford: Aero Research Limited, 1954.) [14

Essex Education Committee. South-West Essex Technical College and School of Art. Annual Report, Session 1952–53. Pp. 30+4 plates. (Walthamstow: South-West Essex Technical College, 1954.) [74

Biological Council. A List of Abbreviations of the Titles of Biological Journals. (Selected by permission, from the "World List of Scientific Periodicals".) Second edition. (London: H. K. Lewis and Co., Ltd., 1954.) 2*s*. 6*d*. net. [74

Department of Scientific and Industrial Research. Road Research Laboratory. Road Research Technical Paper No. 15: Soil Survey Procedure. Second edition. Pp. vi+26. (London: H.M. Stationery Office, 1954.) 1*s*. 9*d*. net. [74

Oundle School Natural History Society. Annual Report, 1953. Pp. ii+38. (Oundle: Oundle School, 1954.) [74

Science Masters' Association. Report of Committee and Balance Sheets, 1953. Pp. 34. (Cambridge: Dr. H. F. Boulind, Science Masters' Association, 1954.) [74

Forestry Commission. Forest Record No. 22: Shelterbelts for Welsh Hill Farms. By W. A. Cadman. Pp. 32 (4 plates). 2*s*. net. Forest Record No. 23: Fires in State Forests in the years 1929–1952. By H. Charters. Pp. 32. 1*s*. 6*d*. net. Forest Record No. 24: Revised Yield Tables for Conifers in Great Britain. By F. C. Hummel and J. Christie. Pp. 24. 1*s*. 3*d*. net. Forest Record No. 25: Japanese Larches at Dunkeld, Perthshire: a Study in Variation. By J. D. Matthews. Pp. 24+8 plates. 2*s*. net. (London: H.M. Stationery Office, 1953 and 1954.) [74

Department of Scientific and Industrial Research. Research at Your Service: How the Department of Scientific and Industrial Research Can Help to Solve Your Problems. Pp. 20. (London: D.S.I.R., 1954.) [74

Other Countries

Reports of the Forest Research Institute of Sweden. Vol. 43, 1953. Pp. iv+584. (Stockholm: Centraltryckeriet, Esselte AB., 154.) 20 kronor. [14

U.S. Department of Agriculture. Agriculture Information Bulletin No. 121: Fighting Our Insect Enemies—Achievements of Professional Entomology. Pp. 25. 15 cents. Farmers Bulletin No. 1566: The Sorghum Midge—with Suggestions for Control. Pp. 6. 5 cents. Leaflet No. 348: The Velvetbean Caterpillar—How to Control It. Pp. 4. 5 cents. (Washington, D.C.: Government Printing Office, 1953 and 1954.) [14

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 35, No. 2: What Our Older People Do. Pp. 12. (New York: Metropolitan Life Insurance Company, 1954.) [14

Veroffentlichungen des Fraunhofer Instituts Freiburg I.B. Sonnen-Zirkular für die monate Oktober, November, Dezember, 1953. Pp. 51. (Freiburg, I.Br.: Fraunhofer Institut, 1954.) [14

Publications of the United States Naval Observatory. Second Series. Vol. 17, Part 3: Observations of Satellites made with the 26-Inch Equatorial of the U.S. Naval Observatory, 1928–47. By A. Hall, Jr., H. E. Burton, U. S. Lyons, L. R. Wylie, G. M. Raynsford, W. M. Browne and J. L. Smith. Pp. iv+93–134. (Washington, D.C.: Government Printing Office, 1954.) [14

Today's Research and Tomorrow's World. By Dr. Vannevar Bush. (An address before guests of the Board of Directors of Stanford Research Institute at a luncheon on Wednesday, January 20, at the Statler Hotel, Los Angeles.) Pp. 16. (Washington, D.C.: Dr. V. Bush, Carnegie Institution of Washington, 1954.) [14

Publications de l'Institut National Turc de Bibliographie. Bibliographie des Articles Parus dans les Periodiques Turcs, 1952–5: Octobre–Decembre. Pp. 138. (Istanbul: Milli Egitim Basimevi, 1952.) [14

Helsingin yliopisto, Meteorologian laitos. Mitteilungen—Papers No. 69: Die Phänologie in Finland 1750–1950. Phänologie und Mikroklima Nachträge. Von Osc. V. Johansson. Pp. 88. Mitteilungen—Papers No. 73: Die Periodizität der Wintertemperatur in Stockholm und Helsinki. Von Heikki Simojoki. Pp. 12. (Helsinki: Helsingin yliopisto, Meteorologian laitos, 1954.) [14

Ministerio de Agricultura: Division de Investigation. Informacion Tecnica. Vol. 1, No. 1: El problema de las razas fisiologicas de Phytophthora infestans (Mont) de Bary. Por Enrique de Rojas Pena, I.A. Contribución a su estudio. Efecto de la N-Triclorometiltio-tetrahidroftalamida en el control de Phytophthora infestans de la papa. Por Enrique de Rojas Pena and Nelson Estrada, R. Pp. iv+78. (Bogota: Ministerio de Agricultura, 1953.) [14

Consejo Superior de Investigaciones Cientificas. Publicaciones del Instituto de Quimica "Alonso Barba". Vol. 7—Ano, 1953. Pp. iv+250. (Madrid: Instituto de Quimica "Alonso Barba", 1954.) [14

Foundation for the Study of Psycho-Physics. Vol. 1: First Report on the Geographical and Geological Distribution of Carcinoma in the Netherlands. By Dr. J. C. Diehl and Dr. S. W. Tromp. Pp. 120. (Leiden: Foundation for the Study of Psycho-Physics, Hofbrouckerlaan, 54, 1953.) 7.95 guilders; 15*s*.; 2.10 dollars. [14

Unesco. Arid Zone Programme—2: Proceedings of the Ankara Symposium on Arid Zone Hydrology. (Jointly organized by the Government of Turkey and Unesco.) Pp. 268+8 plates. (Paris: Unesco; London: H.M. Stationery Office, 1953.) 1500 francs; 30*s*.; 5.50 dollars. [14

Scientific Council for Africa South of the Sahara. Publication No. 5: Second Report—July 1952 to June 1953. Pp. 46. (Bukavu (Congo Belge): Scientific Council for Africa South of the Sahara, 1953.) [14

Smithsonian Institution. Bureau of American Ethnology. Bulletin 152: Index to Schoolcraft's "Indian Tribes of the United States". Compiled by Frances S. Nichols. Pp. vi+258. (Washington, D.C.: Government Printing Office, 1954.) 1.25 dollars. [14

Ministerie van Onderwijs, Kunsten en Wetenschappen. Zoologische Mededelingen uitgegeven door het Rijksmuseum van Natuurlijke Historie te Leiden. Deel 32, No. 21: Hippeococcus, a New Genus of Pseudococcidae from Java with Peculiar Habits. By A. Reyne. Pp. 233–258. (Leiden: Rijksmuseum van Natuurlijke Historie, 1954.) [14

Kungl. Svenska Vetenskapsaladamiens Handlingar. Fjärde Serien. Band 5, Nr. 1: On the Visceral Skeleton in *Eusthenopteron*, with a discussion of the Parasphenoid and Palatoquadrate in Fishes. By Erik Jarvik. Pp. 104. (Stockholm: Almqvist and Wiksells Boktryckeri AB.; London: H. K. Lewis and Co., Ltd., 1954.) 15 kronor. [14

Canada: Department of Resources and Development. National Museum of Canada. Bulletin No. 129: Catalogue of the Recent Mollusca of Canada. By Aurèle La Rocque. (Biological Series No. 44.) Pp. ix+406. 2.50 dollars. Bulletin No. 131: List of Labrador Eskimo Place Names. By E. P. Wheeler, 2nd. (Anthropological Series No. 34.) Pp. ix+106. 1 dollar. (Ottawa: Queen's Printer, 1953.) [14

Skrifter fra Danmarks Fiskeri-og Havundersogelser. Nr. 15: Fiaken og Havet ved Grønland. Af Paul M. Hansen og Frede Hermann. Pp. 128. (København: I Kommission Hos C.A. Reitzel, 1953.) 10 kronor. [14

Union of South Africa. Department of Commerce and Industries: Division of Fisheries. Investigational Report No. 14: The Periodic Mortality of Fish in the Walvis Region. A Phenomenon within the Benguela Current. By W. J. Copenhagen. Pp. 36 (9 plates). (Pretoria: Government Printer, 1953.) [74

Official Records of the World Health Organization. No. 51: The Work of WHO 1953—Annual Report of the Director-General to the World Health Assembly and to the United Nations. Pp. ix+190+16 plates. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) 10*s*.; 1.50 dollars; 6 Swiss francs. [74

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office